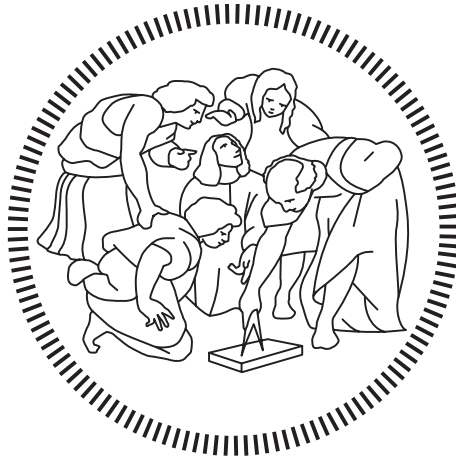


Politecnico di Milano

SCHOOL OF INDUSTRIAL AND INFORMATION ENGINEERING

Master of Science – Management Engineering



**Analysis of the COVID-19 pandemic impact
on cultural institutions: an insight over three
northern Italian museums**

Thesis supervisor:

Prof. Deborah Agostino

Author:

Giuliano Angelini – 914067

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A parte i suoi contenuti, questa Tesi rappresenta il culmine di cinque anni che hanno cambiato la mia vita e soprattutto mi hanno aiutato a crescere. Ci sono molte persone che devo ringraziare, le quali hanno tutte in qualche modo contribuito a permettermi di raggiungere questo importante traguardo. Iniziando dai miei genitori, Dino ed Elena, che hanno sempre creduto in me e nelle mie capacità, provvedendo in questi anni a sostenermi sia economicamente che moralmente. Oltre a loro, ovviamente, devo includere i miei cari nonni Guido e Rita e gli zii Alberto e Sara.

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Abstract (English version)

The health emergency due to the outbreak of the COVID-19 pandemic has revolutionized the lifestyle of modern society on a global scale. This upheaval has had consequent repercussions on the world economy, where it is difficult to imagine a sector that has not been directly or indirectly affected, even with paradoxically positive effects sometimes, by the spread of the virus.

The following Master Thesis focuses on the Italian cultural heritage sector and stems from a project commissioned to Politecnico di Milano by three museums in northern Italy: the Gallerie Estensi of Modena, the Musei Reali of Turin and the Palazzo Ducale of Mantua. The objective of the working group was the construction of a model capable of estimating the economic impact of the pandemic on the museums, with respect to the occurrence of various potential scenarios. The model was built considering both quantitative data and qualitative aspects. In fact, if on the one hand the data provided by the three museums and the statistics made available by the Ministry of Cultural Heritage and Activities and Tourism made it possible to estimate a fundamental parameter such as the number of potential visitors that would have occurred in the absence of pandemic, on the other hand, it is not of secondary importance to consider the sociological and psychological repercussions that the pandemic and the consequent containment measures have had on citizens. Will they be readily willing to visit a public place after what has happened? How much will the new safety regulations impact on a visitor's perception of the "experience" of visiting a museum?

It should also be stressed that this model is not a consequence of an a posteriori study of the consequences of the pandemic, as the research began in the first weeks of March 2020, when the whole nation was facing the lockdown and a crisis which, likely, has been the biggest since the post-war period. Therefore, this Master Thesis is also aimed to describe the development process behind the model, which needed to be adapted to the evolution of health conditions and to progressive ministerial directives, in a situation that has never occurred before and, consequently, in an environment characterized by strong uncertainty and difficulties in making reliable forecasts.

In conclusion, although the model was born as a response to the request of the three aforementioned museums, the hope of the working group is that this will not be limited only to these realities, but that it will become a useful support tool for the whole cultural heritage sector in the management of emergency and post-emergency periods.

Abstract (Italian version)

L'emergenza sanitaria dovuta all'insorgere della pandemia di COVID-19 ha rivoluzionato su scala globale lo stile di vita della società moderna. Questo stravolgimento ha avuto conseguenti ripercussioni sull'economia mondiale, dove risulta difficile immaginare un settore che non sia stato colpito, direttamente o indirettamente e talvolta con effetti paradossalmente positivi, della diffusione del virus.

Il seguente lavoro di Tesi si focalizza sul settore italiano dei beni culturali e nasce da un progetto commissionato al Politecnico di Milano da tre musei del nord Italia: le Gallerie Estensi di Modena, i Musei Reali di Torino e il Palazzo Ducale di Mantova. L'obiettivo del gruppo di lavoro è stato la costruzione di un modello capace di stimare l'impatto economico della pandemia sui musei, rispetto al verificarsi di diversi scenari potenziali. Il modello è stato costruito considerando sia dati quantitativi, che aspetti di natura qualitativa. Infatti, se da un lato i dati forniti dai tre musei e le statistiche rese disponibili dal Ministero dei Beni e delle Attività Culturali e del Turismo hanno reso possibile la stima di un parametro fondamentale come il numero di potenziali visitatori che si sarebbe verificato in assenza della pandemia, dall'altro non è di secondaria importanza considerare le ripercussioni sociologiche e psicologiche che la pandemia e le conseguenti misure contenitive hanno avuto e avranno sui cittadini. Saranno questi prontamente disposti alla visita di un luogo pubblico dopo quanto successo? Quanto le nuove norme di sicurezza impatteranno sulla percezione che ha un visitatore riguardo "l'esperienza" della visita ad un museo?

Occorre inoltre precisare che questo modello non è conseguenza di uno studio a posteriori delle conseguenze della pandemia, in quanto la ricerca è iniziata in corrispondenza delle prime settimane di Marzo 2020, quando l'intera nazione si apprestava a fronteggiare il lockdown e quella che, molto probabilmente, è stata la più grande crisi dal dopoguerra. Il lavoro di Tesi è anche, dunque, focalizzato alla descrizione del processo di sviluppo alla base del modello, per il quale è stato necessario adattarsi all'evoluzione delle condizioni sanitarie e alle progressive direttive ministeriali, in una situazione mai verificatasi in precedenza e, di conseguenza, in un ambiente caratterizzato da forte incertezza e difficoltà nel realizzare previsioni affidabili.

Concludendo, sebbene il modello nasca come risposta alla richiesta dei tre musei sopracitati, la speranza del gruppo di lavoro è che questo non venga limitato solamente a queste realtà, bensì che diventi un utile strumento di supporto per tutto il settore dei beni culturali nella gestione dell'emergenza e del post-emergenza.

Executive Summary

This Master Thesis aims to present the research project that was carried out by a working group of Politecnico di Milano, with the main objective of building a model capable of assessing the economic impact that the COVID-19 pandemic has had on museums. This project was born as a response to a request directly made by three northern Italian museums, which were facing the sudden closure of their regular activities as a consequence of the generalized lockdown in the entire country started on March 9, 2020. These are respectively: the Gallerie Estensi of Modena, the Musei Reali of Turin and the Palazzo Ducale of Mantua.

The World Health Organization officially recognized COVID-19 as a pandemic on March 11, 2020. This has been the beginning of an out of the ordinary period, which led to a real revolution in people daily lives, in social relations, in the ways of conducting business, in the modalities of education and possibilities for cultural enrichment. The global leading consulting firm McKinsey & Company, together with the Oxford University Economic Department, have summarized the two “*imperative of our time*” with the trade-off between safeguarding lives and safeguarding livelihoods. The first translates into with the avoidance of the virus spread while sourcing for a better treatment and the vaccine, while the second can be briefed in the commitment of governments to protect the economy, in particular the businesses most affected by the lockdown effects, together with the preparation for the return to a “partial normality” when the situation will be more favourable. However, what has been considered as certain fact from scholars of the field, is a loss In GDP of the most affected nations between the 8% and the 13%.

It is in this strongly uncertain and new underlying environment that the working group operated, according also to the directives and insights of the practitioners of the collaborating institutions which requested this research project.

After a purely introductory Chapter, this Master Thesis presents the literature review that has been conducted in order to familiarize with the concepts over which the research project is focused. The first part of this process was focused on the concept of museum, of which the most famous definition is provided by the International Council of Museums (ICOM) in 2007:

“A museum is a non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits the tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment.”

This statement is considered as a standard reference for scholars and practitioners of the field, but the research tackled several aspects of museal activities. At first, a historical overview is provided, in which the evolution of museums has been analysed: starting the III century BC, with the erection the Museum of Alexandria in Egypt by King Ptolemy I, and concluding with the present days museum conception, with the latest technological development which have radically changed the visitor experience (G. Beretta & L. Pirti, 2019). Thus, documenting the shift from museum intended as “the sanctuary of the Muses” and a sacral place dedicated to knowledge and culture, to customer driven and business-oriented approach, in which museums are seen as organizations to be managed.

Furthermore, studies about how the concept of museum is integrated within society have been considered. These varies from considering the museum as an institution with educational purposes, to being a complex time-space dimension, capable of narrating histories behind the artwork exposed and creating a link with the audience visiting them (M.T. Balboni Brizza, 2000). There are also scholars which pointed out the possible contradictions that museums might generate, from the possibility of manipulating history (G. Pinna, 2003) to the “*creation of a market of illusions*” (A. Lugli & V. Vercelloni, 2004).

Beside these existential considerations, the research also analysed the current classifications in which museums are grouped, from the general one proposed by UNESCO in 1984, to the list applied by ISTAT in Italy. Precisely, it has been also necessary to consider the fact that, in Italy, the jurisdiction provides a list of museums with special autonomy, the first 20 institutions belonging to this category are identified in the Decree of the President of the Council of Ministers of 29 August 2014, no. 171, in force since 11 December 2014. Nowadays, the number has been augmented to 40 museums, following the Article 33 of the Decree of the President of the Council of Ministers 2 December 2019, no. 169. All of the three northern Italian museums which have requested and contributed to this research project, belong to the first list of 20 special autonomy museums, published in 2014.

Museums have also been studied from an economic point of view, as organizations capable of generating value. Among several studies consulted, the most relevant is represented by the application of Porter Value Chain to cultural institutions. This was made by Michael Porter himself, in 2006, with the publication “*Strategy for Museums*”. According to the author, the primary activities for museums concern the acquisition of cultural heritage for its preservation and further exhibition and communication to the community. To support these activities, processes regarding the infrastructure, the human resources, the financial aspect, the content and the educational programs, must be held.

The museums surplus will depend on the effectiveness and efficiency of these activities which, at the same time, will depend on the value museums are able to deliver to their visitors. It is necessary to notice how, when analysing these particular institutions, Porter does not define the value generated

in financial terms but rather as “social benefits”, a term which includes customer value, community outreach, and public service. This is coherent with many other studies about museums value generation.

After some insights regarding the three northern Italian museums directly involved in this research project, the second part of the literature review tackles the pandemic outbreak and the possible consequences that this extraordinary event might generate. There are several research and studies about the topic, knowledge production is daily enriched by publications made by different authors such as scholars belonging to different fields, statistics institutions, consulting firms. However, if on the one hand gathering information on the underlying environment is fundamental in order to carry out the purposes initially declared at the beginning of the research, on the other the nature of this project is strictly connected to the on-field application of the developed model, allowing museums practitioners to have an easy to use, but at the same time complete, instrument in order to actually assess the magnitude of the losses due to the COVID-19 outbreak. In an uncommon way, part of the literature review process consisted in the continuous being up to date with the latest initiatives undertaken by the Italian government in order to fight the virus spread through the limitations of the number of contagions. The consequences of the continuous limitations concerning mobility and social relationships can be synthesised, as regards the cultural heritage sector, by the following sentence of Antonio Tarasco, the director of Service I of the Directorate General for Museums of the Italian Ministry of Cultural Heritage and Tourism:

“The situation is not happy at all [...]. We have a revenue production method based mainly on ticketing. Therefore, the interruption of the service immediately leads to the suppression of about 90% of revenues, while the other 10% is related to ancillary services.”

In the end, the literature review led to identification of the research gaps that this Master Thesis is supposed to fill, which are expressed in the following two research questions formulated. Off course, when reading this document, it is also necessary to consider the fact that the literature review process has been carried out at the beginning of the COVID-19 outbreak, when uncertainty about future outcomes was at its peak:

1. Which numbers or indicators can be used for assessing the economic impact of the COVID-19 over museums, that can be easily read but complete at the same time?
2. How is it possible to foresee potential evolution of the current scenario (as of March 2020)?

The attempt to answer to these research questions led to the choice of adopting a multiple scenario approach, taking into consideration both quantitative and qualitative aspects. The Table below contains the reference schema over which the model has been developed. Briefly, a large part of the work consisted in exploiting historical data belonging to a pre COVID-19 situation, in order to create a basis for forecasting the expected number of visitors willing to attend museums in the so-called “Phase 2” (coinciding with the reopening of activities) and, at the same time, to have a benchmark for computing the economic losses deriving from the pandemic outbreak.

	Opening	Closure	Reopening (Phase 2)
Visitors	Certain data	0	Forecast of expected visitors
Revenues		€ 0.00	Forecast of the revenue loss due to the number of visitors

Table 1: General framework for the research

The following four key points resume all the hypothesis made by the working group, underlying the presented model:

1. *Who will be able to visit the museum at the reopening?* Despite the strong uncertainty as regards the actual date of the reopening, what was clearly imaginable and suggested, was the fact that the reopening would have been a gradual process and not a total comeback to the pre-emergency normality. To this extent, the concepts of Italian “Region” and “Province” have been exploited; these, together with the Municipalities, Metropolitan Cities and the State itself, represent the five constitutive elements of the Italian Republic and can be intended as “administrative borders” (ISTAT, 2018). The hypothesis of progressive reopening has been formulated using these borders to mark the progressive increment of available audience willing and capable of visiting the museums. This increase of potential public is function of the fact that, if the pandemic conditions will improve, the government will potentially increase the possibilities of people to move across these boundaries, until the point in which travels in the entire country will be allowed (even in absence of a particular motivation), restoring a mobility situation similar to the one previous to the COVID-19 outbreak.

2. *How many visitors will there be at the reopening?* It is possible to forecast the number of expected visitors as regards 2020 using statistical techniques, however this number alone has not been considered as sufficiently precise to estimate the losses occurred in reasons of the pandemic emergency. Indeed, it is necessary to take into consideration the differences in terms of visitors presence across the months of the year, as well as the fact that the frequentation of museums after the attended reopening will be affected by the graduality of the process of return to normality. As concerns this latter component, museums made available data about the attendance of the first week of March 2020, in absence of the emergency measures, which have been used as base to compute the initial number of visitors that these institutions will welcome at the reopening, through the definition of a coefficient named “Participation Rate”.

$$\text{Participation Rate} = \frac{\text{Actual visitors 1}^{\text{st}} \text{ week of March 2020 (COVID)}}{\text{Expected visitors 1}^{\text{st}} \text{ week of March 2020 (no COVID)}}$$

3. *How will the number of visitors grow?* The process of answering this interrogative led to the understanding of the necessity to build a model based on different scenarios. Being the growth of visitors mainly influenced by the mobility conditions, forecasts are realized taking into considerations two main components. The first, is the mobility allowed by governmental institutions. As previously mentioned, for this component the Italian administrative borders have been considered as a good proxy of what could happen in the future: the more the health conditions will improve, the larger will be the bounders in which individuals will be able to move without restrictions. The second component, instead, is related to a more socio-psychological aspect. Several experts wonder about the impact of the restrictions activated as a response to the health emergency on the society in general, Zignale (2020) mentioned that: *“It is clear that in a context of restriction of mobility, in addition to the various physical and real movement implications of the individual, a fundamental part is reserved for the psychological aspect that the restriction imposes. Feeling limited, suddenly, by an institutional restriction, due to a global health alarm, which blocks daily mobility, determines, on a psychological level, the degree of emergency we are about to face.”* Bertocci et al. (2020) also point out that the fear sown by the contagion from COVID-19, which has hit most in urban centres due to the greater density and mobility of the population, will continue to constitute a fundamental socio-natural relational element in infra, inter and extra-urban life. Due the multi-scalar volume of mobility, from micro to transnational, this brings consequences for safety, the environment and health. It will therefore be necessary to re-imagine new methods of transportation. Giungato (2020) refers to a state of persistent fear in which the common citizen has found himself immersed in the days of lockdown,

alimented by the continuous succession of alarming and crude images. One above all, the procession of wagons of the Italian Army that leads to cremation the bodies of the dead, crossing in silence a night and deserted Bergamo, comparing this image to the image described by Manzoni in the novel “*I Promessi Sposi*” (1827), of the cart completely covered with naked corpses and marked by evident signs of the disease, crossing the streets of Milan during the plague epidemic of 1576. These are the reasons which lead the working group to include also a coefficient aimed at taking into consideration the willingness of people to move and its growth month after month. The Figure below provides an overview of the 24 scenarios identified crossing these dimensions, the x and y axes relates to the mobility scenarios allowed by the government, presenting an expected date for the regional mobility (y axis) and then the national mobility (x axis). This Cartesian plane is replicated three times, once for each level of the aforementioned Growth Rate, of which a value equal to 5% has been identified as pessimistic, 10% as intermediate and 20% represents the most optimistic point of view.

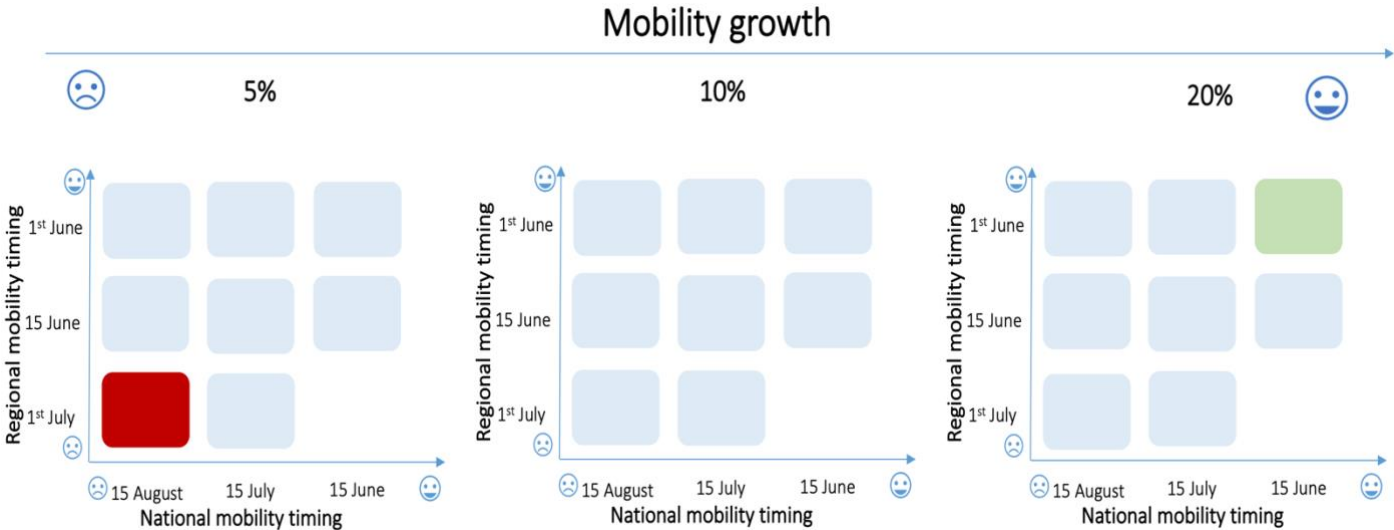


Figure 1: The Multiple Scenarios Model

In this representation, the red block constitutes the most pessimistic scenario, in which the possibility of an individual to move inside its home Region is denied until July 1 and the mobility around the national territory will be allowed only after August 15, with a Growth Rate imposed at 5%. On the other side, the green block is equivalent to the most optimistic scenario, with regional mobility allowed from June 1 and the permission to travel around Italy starting from June 15, together with a Growth Rate equal to 20%. The dates used were chosen consistently with the measures adopted by the Italian government in the first half of the year 2020.

The generalized formula for computing the visitors in a certain month *i*, is given by:

$$\# \text{ visitors } Month_i (\text{COVID}) = \# \text{ visitors } Month_i (\text{no COVID}) \times \text{Participation Rate} \times (1 + \text{Mobility Coeff.}) \times (1 + \text{Growth Rate})^i$$

From this, it is possible to compute the loss in terms of visitors as the difference between the expected visitors in case of absence of the COVID-19 outbreak and the numbers computed with this technique. Month by month, it results in:

$$\Delta \text{ visitors } month_i \text{ 2020 (COVID)} = \# \text{ visitors } month_i (\text{no COVID}) - \# \text{ visitors } month_i (\text{COVID})$$

4. *How to convert these results into economic terms?* In order to obtain the economic assessment of how this loss in terms of audience will impact on cultural institutions, it has been possible to exploit field data of the collaborating institutions regarding 2019. Indeed, a Monthly Revenue per Visitor Coefficient has been defined, which provides the weight of each month i in terms of revenues from visits:

$$\text{Monthly Revenue per Visitor Coefficient}_i = \frac{\text{Revenues from entry tickets}_i}{\text{Number of visitors}_i}$$

A synthesis of the forecasted losses, for each of the northern Italian institutions which contributed to the research project, is showed in Figure 2.

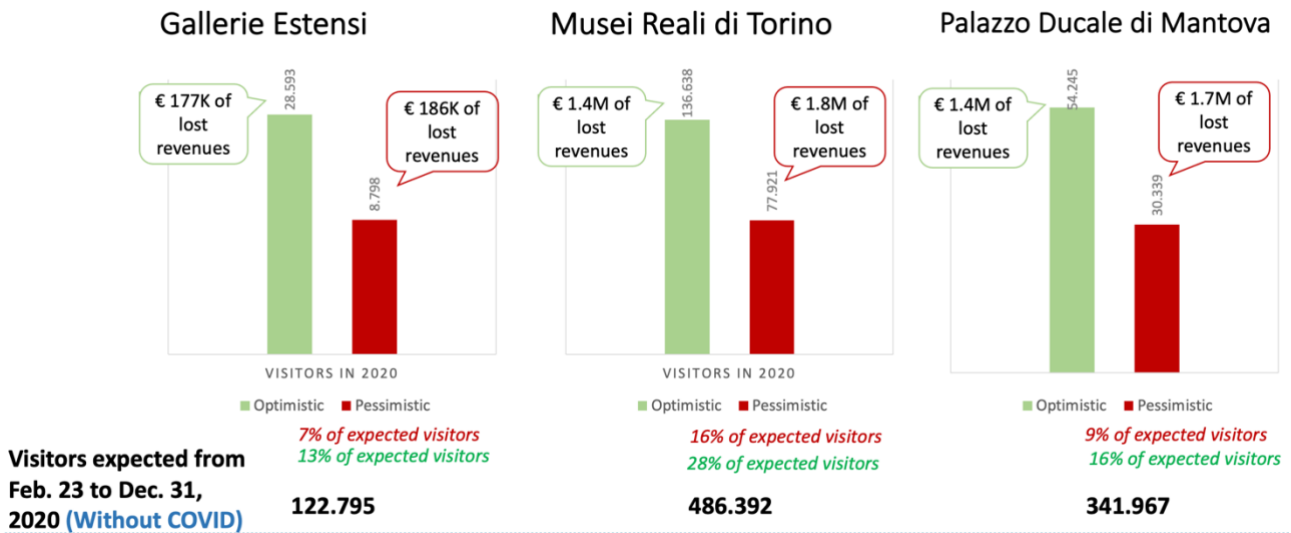


Figure 2: 2020 losses computed through the application of the model

Furthermore, it has also been possible to test the goodness of the Multiple Scenarios Model by collecting data starting from June 2020, in which the Italian government actually allowed the reopening for cultural activities, till the end of October when the second wave of the virus and the consequent new dispositions led to another closure period. In addition to this, it is also necessary to mention that due to complications arose consequently the health emergency and to issues related to the management of the museums itself (one above all the nomination of the new Director), the Palazzo Ducale of Mantua has been unable to follow the second part of this research project, and not even to collaborate with the working group and the other two requiring institutions for the monitoring of the context verified after the general lockdown. However, the numbers measured in this interval of time have been quite close to the forecast range generated through the application of the model. Chapter 5 is dedicated to the analysis of the results and to test the goodness of the Multiple Scenarios Model. A synthesis of the impact that the ongoing pandemic had on the collaborating museums is provided in Table 2, both in terms of visitors and in an economic sense.

	Gallerie Estensi of Modena		Musei Reali of Turin	
	Visitors	Revenues	Visitors	Revenues
2019	52,770	€ 95,886.30	177,875	€ 983,442.84
2020	11,426	€ 20,603.52	51,161	€ 317,404.00
Losses (%)	78.34%	78.51%	71.24%	67.73%

Table 2: Museums field analysis from June to October 2020

If, on the one hand, the main purpose of this Mater Thesis can be considered achieved, on the other it is also true that the discussed model is subjected to some limitations, which can briefly be grouped into:

- *The adopted forecasting technique:* even though the method chosen in order to compute the forecasts about the number of visitors does not have to represent a constraint in the application of the Multiple Scenarios Model, the linear regression used for this application to the three northern Italian museums may result in an extremely simplistic representation. This choice has been a consequence, in the very first days of development, of quickly obtaining data to analyze. Moreover, the museums themselves required calculations of simple interpretation;
- *The qualitative approach in estimating Growth Rate values:* this is one of the key parameters of the presented model, weighting how the audience will grow overtime. For the same reasons discussed in the previous point, the choice made by the working group results in an extreme

simplification of this parameter. Indeed, even though agreed with the collaborating institutions, presenting a fixed range of only three possible values may not be considered satisfactory for subsequent studies. To overcome this issue, a more direct approach towards the public can be a possible solution, being this coefficient synthesizing their willingness to join, again, the place of culture. As an example, in the ambit of this research project, the working group also created a short survey that these northern Italian museums submitted to their audience through social media and newsletters. For reasons due to the timing and the fact that, at that time, a lot of questionnaires have been proposed to the general public, the number of responses has been quite low and, therefore, the sample has not been retained sufficiently reliable in order to be considered relevant for this Master Thesis.

Despite these limitations, the aim of this model must not be an application for its own sake. On the contrary, the Multiple Scenarios Model has been thought for being a support for policies and managerial choices. Particularly, the ones concerning the modalities in which the “new normal” of cultural fruition will be realized, through investments aimed to fill the relevant gaps in terms of digital technologies and skills that cultural institutions have with respect to other sectors of the economy (D. Agostino, M. Arnaboldi & E. Lorenzini, 2020).

Concluding, the Multiple Scenarios Model can also be applied to other cultural institutions. These institutions are not forcedly supposed to be just museums, since is also possible to consider other places of the culture such as libraries, archives, archaeological areas and parks, exhibitions, theatres and cinemas, not forcedly linking the developed model to the Italian context only.

1. Introduction

The outbreak of the COVID-19 pandemic has been the beginning of period full of changes in the social and working lives among all the citizens living in the countries in which the virus has spread the most. A definition of pandemic is provided by Dr. Keiji Fukuda Assistant Director-General ad Interim for Health Security and Environment at the World Health Organization, who stated that “*A simple way to think about the pandemic is to say: [...] a pandemic is a global outbreak. It means that we see both the spread of the infectious agent [...] and the activities of the disease, as well as the spread of the virus*” (WHO¹, 2009). In addition to this, experts recognize that declaring a pandemic can be politically burdensome because it can shake markets, lead to more drastic restrictions on travel and trade, and stigmatize people from the first affected regions, even though it can spur countries to prepare for the possible arrival of the virus (Time, 2020). Briefly, what has been under discussion by the major institutions was the trade-off between the safeguard of people life and health, versus the damages to the economic welfare that the restrictive measures could have brought to a country economic system.

This Master Thesis is far from being a discussion about what could have been the best approach to fight the spread of the virus, nor does it want to be an analysis about all the crisis due to pandemics that mankind has undergone. The research is focused on the Italian cultural heritage sector and this document is aimed at the description of all the steps that were necessary for the research group in order to build a model capable of assessing the economic loss that the pandemic brought to cultural institutions. The model has started to be developed in March 2020, after the beginning of the generalized lockdown in Italy and the “*official characterization of COVID-19 as a pandemic*” by the World Health Organization. Due to the newness and unpredictability of the general context, the research group imagined since the beginning of the development period that some (if not all) of the variables and scenarios considered could have been affected by the decisions undertaken from the Italian Prime Minister Giuseppe Conte together with the Scientific Technical Committee. However, the model just shows the possible outcomes that the three museums under analysis will face upon occurrence of different scenarios, it has not to be imagined as a tool for evaluating the goodness of a certain choice, especially when considering the complexity and the weight of the decisions that the government has had to take along this revolutionary period.

¹ World Health Organization

Nevertheless, before deepening all the aspects related to the model, it is necessary to understand the causes behind its development and the underlying context in which the research group worked. The following Paragraphs of this Chapter are aimed at providing knowledge about the impact that a pandemic might have, together with its possible consequences. Moreover, even though the research has been conducted with the only three museums of Modena, Turin and Mantua, the model has been thought to be a useful instrument for all the other similar cultural institutions as well. To this extent, an overview of the Italian cultural heritage sector is then reported, while further specific information related to each of the three above mentioned museums are included in Chapter 2.

1.1 Outbreak of a pandemic and main consequences

The World Health Organization officially declared COVID-19 as a pandemic on March 11, 2019. What is generally confused, using a common and nonspecific language, are the respective meanings of epidemic and pandemic. Although they are often used interchangeably, the former indicates the frequent and localized, but limited in time, manifestation of an infectious disease, with widespread transmission of the virus. The epidemic occurs when a sick person infects more than one person and the number of cases of the disease increases rapidly in a short time. The infection then spreads in a population consisting of a sufficient number of susceptible individuals. The second term refers to the spread of a disease in several continents or in any case in large areas of the world. In 2009 the World Health Organization defined six phases of a pandemic: in order the neutral phase, the interpandemic phase, the alert phase, the pandemic phase, the transition phase before returning to the interpandemic phase. The pandemic phase is characterized by transmission to the majority of the population. Certainly, COVID-19 is not the first pandemic humanity has ever faced, it is possible to mention diseases starting from the classical era. The following list reports the main pandemics occurred starting from the beginning of the XX century:

- *The Spanish Flu, 1918-1919*: it began in August 1918 in three different locations: Brest, France; Boston, Massachusetts and Freetown in Sierra Leone. It was a particularly violent and lethal strain of flu. The disease has spread around the world, killing 50 million people. It disappeared after 18 months;
- *The Asian Flu, 1957-1960*: first detected in China in February 1957, it later reached Europe and the United States, causing about 2 million deaths worldwide. The strain was H2N2;
- *The Hong Kong Flu, 1968-1969*: the H3N2 strain, which emerged in Hong Kong in 1968, reached the United States in the same year where it claimed 34,000 lives. It caused about 2 million deaths worldwide. An H3N2 virus is still around nowadays;

- *Influenza A H1N1, 2009-2010*: also known as "Swine Flu" because it is transmitted from this animal to humans. Its initial outbreak originated in Mexico, then spreading to nearly 80 countries in just 2 months. In Europe and neighbour countries, as of 31 August 2009 there were 46,016 confirmed cases and 104 confirmed deaths. In the rest of the world there were 2,910 confirmed deaths. As of August 6, 2010, when the WHO officially declared the end of the pandemic, there were 1,632,710 confirmed cases and 18,449 deaths;
- *The HIV / AIDS epidemic, from 1981*: it spread exponentially in all countries of the world. Since 1996, drug therapy has blocked the course of the immunosuppressive syndrome (at least in those countries where patients can access drugs), even though it did not eliminate the virus from the bodies of individuals; despite the fact that the disease is now chronic and rarely lethal (in the developed world), its contagion keeps spreading and this is linked to behavioural factors. As of 2018, approximately 37.9 million cases and 32 million deaths are recorded;
- *COVID-19, since 2019*: it is a pandemic of the respiratory disease COVID-19, caused by the SARS-CoV-2 Coronavirus, originating from Wuhan (China) and spreading rapidly around the rest of the world in 2020. It is the first epidemic to be declared a pandemic by the WHO after the publication of the guidelines in 2009.

To understand the macroeconomic impact of a pandemic, it is useful to clarify the channels by which the spread of an infectious virus can affect the world economy. A first channel is the direct effect it has on the health system of the countries involved, which are called to bear significant costs for the care of sick people and for the measures to contain the infection; these costs relate to both the expense for medical-health devices and that for hospital staff overtime. However, the main damage to the economy is likely to be indirect. Among these it is possible to highlight:

- A reduction in the supply of work due to the illness (or in the most serious cases the death) of a large number of workers or the need to take care of sick family members, with a consequent decrease in productivity;
- The temporary closure of companies, shops, schools, public services to limit the infection in the affected areas;
- A sharp decline in consumer demand, especially in the sectors deemed riskier, above all: tourism, catering, cinemas, museums, theatres, sport events, retail sales of non-essential goods and transports;
- A collapse of international trade and foreign investment.

The following mentioned studies, which are at a macroeconomic level, served as an initial screening for the working group in order to understand the impact of what could follow in the near future. The results of almost all the studies report simulations based on econometric models of general economic equilibrium. These results therefore depend on the characteristics of the models and on the assumptions about the extent of two fundamental variables: the "attack rate" of the virus (i.e. the percentage of the population that gets sick) and its "lethality rate" (i.e. the percentage of infected who dies).

McKibbin and Sidorenko (2006) have considered three scenarios, which trace the three pandemics of the last century. In the "milder" scenario (similar to the Hong Kong Flu of 1968-69), deaths amounted to 1.4 million and the negative effect on world GDP in the first year after the outbreak of the pandemic is equal to 0.7 percentage points; in the "moderate" scenario (similar to the Asian flu of 1957), in which 14 million deaths are expected, world GDP falls by 2 percentage points compared to the expected growth, while in the more "severe" scenario (similar to the 1918-19), in which deaths rise to 71 million, the decline in the first year reaches 4.8 per cent. It is important to note that, even in the most unfavourable scenario, the impact of the virus on the economy is reduced in the second year and tends to recover almost completely starting from the third, when the GDP begins to converge at a level only slightly lower than that predicted before the pandemic, as deaths have permanently reduced the supply of jobs anyway.

Burns et al. (2008) take up the Spanish Flu scenario seen in the previous paper and estimate a decline in global GDP of 3.1 percent in the first year, with a stronger negative effect for emerging countries. In this case, however, most of the decline (around two thirds) is due to demand-side shocks, because consumer behaviour changes.

Verikios et al. (2011) simulate the quarterly effects of two pandemics: a not very contagious but very lethal virus (3% attack rate, 10% lethality rate) and a very contagious but not very lethal virus (40% attack rate, lethality rate of 0.5%). In both cases, the peak of the negative effect on GDP occurs in the second and third quarters after the outbreak of the pandemic. Subsequently, the economy gradually returns to the previous trend, settling on a level only slightly lower (for the same reason seen above). However, the magnitude of the impact on GDP distinguishes the two scenarios. In the mildly contagious virus scenario, global GDP falls by 0.3 percent in the first year and by 0.1 percent in the second, with a similar effect on employment; the impact on international trade is instead double that of GDP, causing greater economic damage for those countries that most depend on trade and tourism. In the scenario with a very contagious virus, on the other hand, during the first year world GDP falls by 3.3 percent, with peaks of 4-4.5 percent in the second and third quarters; for employment and international trade the quarterly peaks are even lower (-6.5 percent and -5 percent, respectively). As

already seen in Burns et al. (2008), even in this simulation it is the shock on the demand side that determine the very negative effect of the first year. Other studies have instead simulated the effects on the economy of some macro areas.

A Congressional Budget Office report (2006) simulated the effects of two different pandemics on the US economy. In the event of a more "severe" pandemic (30% attack rate, 2.5% lethality rate) and assuming an average three-week absence from work, in the first year the US GDP would fall by 4.25 percent of the pandemic-free trend; of this decline, 2.25 percent would be due to supply-side shocks and 2 percent from demand-side shocks. In the milder scenario (25% attack rate, 0.1% lethality rate, average absence from work of 4 days), however, the pandemic would reduce GDP by 1 percent in the first year, with the same contribution of the two types of shocks. Finally, the European Commission (2006), taking up the more "severe" scenario of the CBO report just described and assuming that the pandemic lasts a quarter, calculated that the negative effect on European GDP would be 1.6 percent in the first year (of which two thirds due to supply shocks) and 0.5 percent in the second and third year. Part of the fall in GDP would therefore be recovered fairly quickly, although GDP would still converge at a level slightly lower than that predicted before the pandemic (due to the permanent reduction in the supply of labour, as mentioned above). In this context, the Mediterranean countries (especially Spain and Greece) would suffer worse economic damage because they are more dependent on tourism. If we then consider stronger demand-side shocks, of the order of magnitude of those hypothesized in the CBO report for the US, the drop in European GDP would be 3.3 percent in the first year.

In general, the following main conclusions have been drawn:

- The extent of the economic impact of a pandemic depends heavily on the assumptions about the severity of the contagion: a "mild" pandemic, similar to the Asian Flu of 1957 or that of Hong Kong of 1968-69, would have a limited effect on world GDP, typically less than 1 percent per year, while a more "severe" pandemic, similar to the Spanish Flu, could produce effects of even 3-5 percent per year;
- The effect on international trade is stronger than that on GDP, so the economic damage is greater for the countries that most depend on international trade;
- In determining the extent of the impact, both supply-side shocks (lower labour supply, lower productivity, higher costs for businesses) and demand-side shocks (reductions and/or changes in consumption due to panic) are important.

Synthesizing, looking at the number provided by these studies and the beginning of the total lockdown in Italy as of March 9, 2020, it was clear at that time that, even without knowing exactly the entity of

the consequences that the pandemic could bring, the economic, social and health conditions would have been disrupted by the spread of this virus (at least in a short period view). After having gained a necessary high-level macroeconomic perspective, it was necessary to shift attention to the Italian cultural heritage sector, towards which this model is focused. The next Paragraph is intended to provide an overview of the structure and numbers of this before the outbreak of the health emergency.

1.2 Overview of the Italian cultural heritage sector

According to ISTAT, in 2018 Italy boasts 4,908 museums, archaeological areas, monuments and eco-museums open to the public. It is a widespread heritage throughout the territory: in one out of three Italian cities (2,311) there is at least one museum-like structure. There is one every 50 km² and one every 12,000 inhabitants. Most are museums, galleries or collections of collections (3,882), to which 630 monuments and monumental complexes, 327 archaeological areas and parks and 69 eco-museum structures have to be added.

Among museums, archaeological areas and monuments, the regions with the highest concentration of structures are Tuscany (553), Emilia-Romagna (454), Lombardy (433), Piedmont (411), Lazio (357) and Veneto (304).

Rome, Florence, Turin, Milan, Bologna, Trieste, Genoa, Naples, Venice and Siena are the top 10 cities with the greatest number of testimonies of the historical-cultural, architectural and archaeological richness of Italy. In addition to the centres of greatest attraction, there is no shortage of places of cultural interest even in small and very small Italian municipalities: 16.1% of the museums are present in municipalities with less than 2,000 inhabitants, some of which can count up to 6 structures, while 30% is located in municipalities of 2,000 to 10,000 inhabitants.

Although still limited in number, eco-museums are an emerging reality, today mainly present in Valle d'Aosta, Piedmont, in the province of Trento, Calabria and Veneto. This testifies the widespread wealth in the area, not contained in a physical structure, together with the growing willingness of even small local realities to preserve and promote the historical memory, cultural identity and artistic resources of the places through projects that involve local communities.

Briefly, the importance of the museums sector, and in general of artistic and cultural tourism, is related to the peculiarities of the Italian heritage, which is for sure one of the most various and important of the world, as testified by the fact that Italy records the highest number (50) of sites inscribed on the UNESCO Cultural World Heritage List.

As of 2017, ISAT have also reported that Italian cultural institutions employ more than 38 thousand operators between employees, external collaborators and volunteers: on average one for every 3,106 visitors (45 thousand in 2015, one for every 2,400 visitors).

Table 3 below proposes an overview of how Italian cultural institutions are divided, both in terms of function and ownership, and their respective distribution in the territory of the peninsula.

Geographical areas	Main function					Ownership		
	Museum, gallery and/or collection	Archaeological area	Monument or monumental complex	Eco-museum	Tot.	State	Not state	Tot.
Nord-west	81.7%	4.1%	11.5%	2.7%	100%	4.9%	95.1%	100%
Nord-east	86.1%	2.5%	9.8%	1.7%	100%	5.3%	94.7%	100%
Centre	77.2%	6.5%	15.4%	1.0%	100%	13.0%	87.0%	100%
South	77.0%	8.4%	13.8%	0.8%	100%	19.7%	80.3%	100%
Islands	67.3%	18.4%	14.2%	0.2%	100%	3.5%	96.5%	100%
Italy	79.1%	6.7%	12.8%	1.4%	100%	9.4%	90.6%	100%

Table 3: Cultural institutions divided by main function and ownership as of 2018 (ISTAT)

From 2006 to 2018, the audience of Italian cultural heritage increased by almost a third (32.2%), growing on average at a rate of over 2.5 million visitors a year. In particular, the use of state museums, monuments and archaeological areas has almost doubled, passing from 34.6 million to 54.1 million visitors, and the public of non-state structures has also grown, albeit more slowly: from 62.7 million in 2006 to 74.5 million. Figure 3 shows this percentage increase in the considered analysis period.

In recent years, the expansion of the visitor base has seen a significant acceleration: in just one year, visitors to Italian museums have increased by almost 10 million. In 2018 there was thus a record number of 128.6 million admissions (+ 8% compared to 2017): 63.4 million in museums, 51.1 million in monuments, 13.7 in archaeological areas and 488 thousand in eco-museums.

Recalling what the previous table has shown, the state structures, 460 including museums, archaeological areas and museum monuments, attracted, last year alone, about 54 million visitors (equal to 42% of the total), with an average audience of four times greater than the non-state one (on average almost 120,000 people per state institution against 19,000 per non-state institution).

The 4,448 non-state owned structures (largely represented by institutions with municipal ownership, equal to 2,037, 41.5% of the total) do not exceed 2,000 visitors per year in almost half of the cases (46.5%), carrying out a service of cultural supervision often aimed above all at the local community. Moreover, it is worth to mention a number of 58.6 million foreigners who, in 2018, decided to visit the Italian cultural heritage was estimated (46% of the total public), this underlines how the Italian cultural heritage is a source of attraction for foreign tourism. Almost half visited the museums (45.9%), 42% the monuments and 12% the archaeological areas.

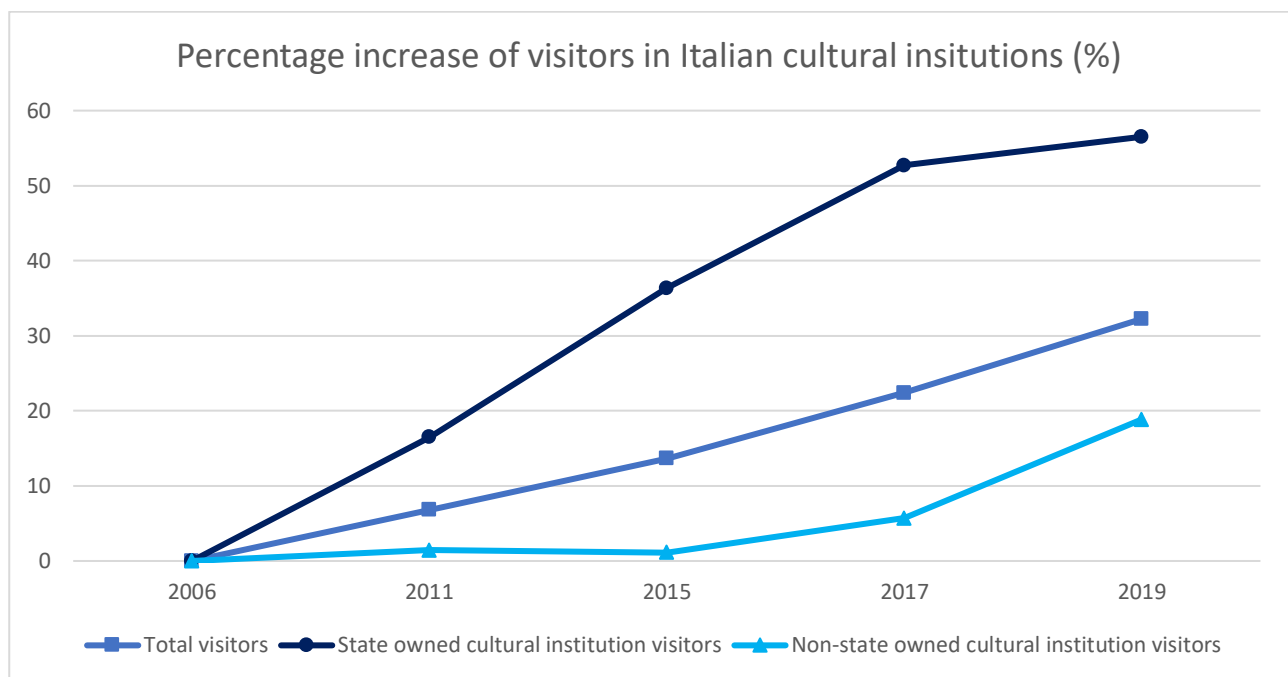


Figure 3: The percentage increase of visitors in Italian cultural institutions (ISTAT)

Concluding this Paragraph with a general overview of the weight of the cultural and creative sector over a country economy, it is possible to mention that in 2003 this sector produced 2.6% of GDP, against 2.1% of the real estate sector, 1.9% of the food, beverages and tobacco sector, 0.5% of the textile sector and 2.3% of the chemical, rubber and plastic sector in Europe. In the 1999-2003 period, the cumulative growth of the cultural and creative sector was 19.7%, with a positive spread of 12.3% compared to the growth rate of the whole European economy.

Therefore, even in the middle of the last decade, the cultural and creative sector was already of great economic relevance and one of the most dynamic components of the entire European system. *“The available information led to affirm that the relative weight of the cultural and creative sector in the European economy from 2006 until today has further increased rather than decreased”* (G. Beretta & L. Pirti, 2019).

1.3 Preliminary research presentation

Before going deeper with the discussion regarding the real objective of this Master Thesis, it is necessary to explain what are the main reasons that led to the development of the model hereby presented.

First of all, the research project has been commissioned by the three aforementioned institutions of Modena, Turin and Mantua made to Politecnico di Milano. What they were seeking was an analytical tool capable of assessing the magnitude of the loss that they would encounter in the months following the Italian complete lockdown. The outbreak of the pandemic caught every sector by surprise, companies and institutions have had to redesign and adapt their practices, balancing between their needs and what was permitted by the law, in order to safeguard both their businesses and, at the same time, the safety of people around them. Being the “on-site visit” the main value proposition of museums and cultural institutions in general, it was clear that the cultural heritage sector would have been one of the most thoroughly affected by the COVID-19 pandemic.

Managing and adapting the museum activities in response to the health emergency requires sector specific experience and capabilities, which the working group does not possess and that surely belongs to the museums committee who chose Politecnico di Milano to help them in managing this phase. Despite this, due to the uncertainty of the context, it was clear that even a skilled and expert team would have faced difficulties in managing such a complex situation, this is the reason that led to the construction of a tool capable of being easily readable and usable but, at the same time, which took into consideration the fundamental parameters for the most exhaustive modelling possible.

What the working group wanted to provide to the three museums is a reliable forecast of what could happen under different scenarios, letting practitioners with an instrument allowing them to evaluate the results, in terms of revenues and visitors, obtained after the post-lockdown reopening. Comparing a museum to a common business firm, the principle behind is that is the management control cycle (Figure 4). Indeed, despite the extraordinary historical phase undergoing, having a reference to which compare actual numbers is fundamental in order to understand the performance of the entity under consideration and whether to introduce corrective actions (M. Arnaboldi, G. Azzone & M. Giorgino, 2015).

The fact that the instrument derives from the explicit request of the three Northern-Italian museums, has not to be perceived as a limitation of it. On the contrary, having had the possibility to interact with people directly involved with the reopening of the cultural institutions has been an advantage in the development of the model and it has helped the working group to gather the perspective of the operators of the sector, focusing on what was really needed and important to observe for them.

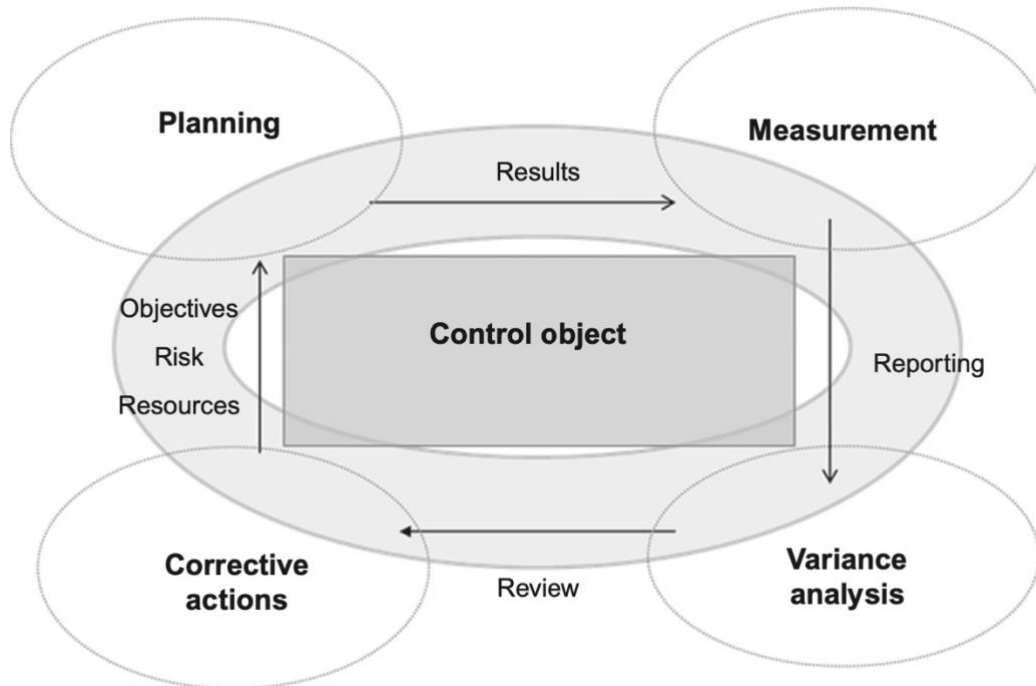


Figure 4: The management control cycle (M. Arnaboldi, G. Azzone & M. Giorgino, 2015)

Going further in this Mater Thesis, Chapter 2 provides a literature analysis, deepening some of the already existing contributions. More in detail, the Chapter presents several museum definitions, objectives and values. Moreover, an overview regarding the three institutions under analysis is reported. Finally, the discussion is moved to the pandemic scenario, gathering knowledge on the COVID-19 disease itself and on instruments which can be helpful for modelling the context. Indeed, the literature review process helped identifying the path to follow in order to have a way of modelling as sticked as possible to reality, being conscious that the strong uncertainty of the moment would have led to one or more changes to the variables selected.

Afterwards, Chapter 3 shows the methodology concerning the whole Master Thesis: specifically, the approach followed for the realization of literature review, the formulation of the research questions, the modalities in which data have been gathered and the supporting tools which helped the analysis concerning this research project.

Chapter 4 is aimed to describe all the steps undertaken to develop the model, together with its functioning and the underlying hypothesis, while Chapter 5 presents the comparison between what the forecasts made through the application of the model and the actual numbers of the three museums after the reopening, from June to October 2020.

Finally, Chapter 6 summarizes the results achieved and how the Master Thesis could be helpful to the whole cultural industry after the shock due to the health emergency, taking into account both

academic and managerial implications. The conclusions highlight how this Master Thesis contributed to the existing literature, taking also a critical perspective by analysing the current limitations of the presented model together with possible directions for future research.

The roadmap reported in Figure 5 below synthetizes what just said about the structure of this Master Thesis.

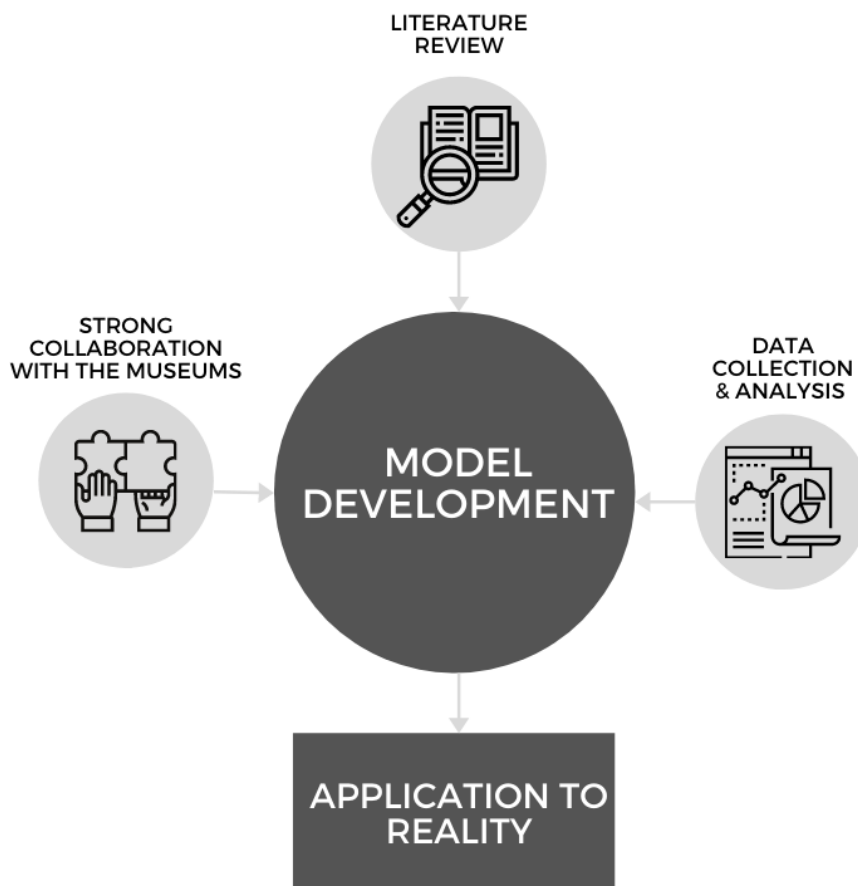


Figure 5: Master Thesis roadmap

2. Literature review

In this Chapter is reported the literature development related to the concept of Museum and the modelling tools that might be used for dealing with the particular COVID-19 situation. More in detail, it is composed of three main parts according to the scope of this Master Thesis.

The first part explains cultural institution as a concept that has changed over time, introducing also some classifications and the activities that can generate value.

The second part presents an insight on the three northern Italian museums which have proposed and contributed to the research project: the Gallerie Estensi of Modena, the Musei Reali of Turin and the Palazzo Ducale of Mantua.

At the end, the third part reports an insight about the phenomenon of the pandemic, in order to understand the potential impact that the COVID-19 could bring in economic and social terms, focusing particularly over the Italian scenario, in which the three collaborating institutions are located and operate.

2.1 Museums

The goal of this Paragraph is to deepen the concept of Museum, which is ancient but has changed over the centuries. First of all, the historical origins of museums are presented, together with their evolution. Indeed, it is possible to identify a typology of museum for every age, pointing out the different characteristics. Secondly, a series of definitions of the concept under analysis is provided, both from institutions and scholars of the field, in order to have a wider range of interpretations.

Going further, it is reported a classification of the main typologies in which it is possible to classify a museum nowadays, together with a brief description of the features of each of these categories.

In conclusion, after having introduced the activities belonging to a general museum, the Paragraph ends with a discussion about how these institutions may generate value.

2.1.1 Museums evolution and historical remarks

As mentioned by Cataldo (2007), collecting and conserving objects is an anthropological phenomenon which has been a habit since prehistory: keeping former objects and memories of ancestors was a custom already in prehistory. From the age of copper to Hellenism, many ancient populations used to place funerary object and relics in their tombs, thus this could be considered as a proof of the strong relation between men and objects.

Another anthropological phenomenon, with also religious implications, is accumulation. Ancient civilization such as Mesopotamian, Egyptians and Greeks used to possess rich collections, often composed of various objects, usually aimed to celebrate a divinity, a sovereign, or even a city or a particular place, mixing mystical and religious traditions to profane intent.

Nowadays, well known archeologic sites such as the pyramids, the ziggurats, the Etruscan tombs and the temples of the Greek cities, can be considered and are often “sold” to the general public as a form of museum. Despite this, the original purpose of these constructions together with the treasures and collections placed inside of them, was to keep company with the deceased or to make sure that gods would have blessed him. Thus, their original scope is quite far from the current purposes of museums. The first historical evidence of a “museum facility” dates back to the III century BC, when King Ptolemy I erected the Museum of Alexandria in Egypt. This place was thought and built as a meeting place for scholars and teachers, representing for centuries the greatest cultural institution in the Hellenistic world. Doing an etymological analysis of the word museum, it is possible to highlight how this derives from the Greek term “Mouseion”, literally sanctuary of the Muses. These were the nine daughters of Zeus and Mnemosyne, each of them considered responsible and protector of a scientific discipline or of an art, more precisely: history, dance, astronomy, epic poetry, lyric poetry, sacred poetry, music, comedy and tragedy. This is the motivation that led the Egyptian pharaoh to endow the museum with a library containing 490,000 volumes, a lodging for the academic community that was frequenting it, a refectory, a laboratory, a botanical garden, a menagerie, an amphitheatre and an astronomical observatory. The Museum of Alexandria was therefore considered as a place of worship that hosted a scientific and literary community, which was performing its activities of cultural enrichment and production with the blessing of the Greek Muses. Among the figures who were frequent visitors of this museum, it is possible to mention the mathematicians Euclid and Archimedes, the intellectual Eratosthenes and Erofilo, the founder of experimental medicine.

Moving forward, if the Greek culture proposed the act of collecting as way to maintain and enlarge the cultural heritage, there are also other motivations which have driven this phenomenon during the Roman Empire. Indeed, during this age a change in the conception of the museum happened, moving from an educational and cult institution to a mean for showing private collections of treasures. A large part of these consisted of war loots or objects stolen to the defeated enemies, which were exhibited on the streets of Rome, in order to celebrate the military victory. Moreover, it was a common practice to place Greek sculptures in private mansions belonging to the current Roman emperor, as an example Hadrian Villa in Tivoli. Greek cultural heritage was undergoing a deep shift, losing its religious function while acquiring a mere aesthetic and symbolic value. In this context, Roman patricians began to collect objects as a symbol of beauty and prestige, spreading at the same time the perception of

collecting art works as if it were a pastime. There are several witnesses about the fact that the Roman nobles hosted large and various collections of art and natural objects in their houses. To this extent, it is possible to quote the English antiquarian David Murray (1904): *“While the Romans were industrious collectors of statues and paintings they sought after them merely as decorative objects [...] at first they were employed exclusively for the decoration of temples and places of public resort; but public collections began to be formed [...] it had become fashionable for wealthy citizens to have a room in their houses for the display of works of art. Vitruvius, writing at the time of Augustus includes the pinacotheca amongst the apartments of a great house and gives directions as to its form and aspect.”*

In the Middle Ages, the tendency seen during Roman period to acquire relics and objects from travels and as war loot continued. During this period, the Church became the protagonist of collecting, the most researched objects were martyrs remains or anything that came into contact with saints. The accumulation of these objects has given way to the so-called treasures, kept in small rooms or isolated chapels, which progressively became coveted pilgrimage destinations (K. Pomian, 2004). The first real treasures date back to Charlemagne, who gathered a great treasure in the chapel of Aachen along with a large collection of books, relics and period objects, later donated to the Church in exchange for eternal salvation. The age of the crusade began the second formation of treasures, for example the treasure of San Marco in Venice. Therefore, the Church was the first to be the true keeper of objects and the first to dedicate the preparation of these objects in a museographic focus (L. Cataldo, 2007). During Humanism, the passion for ancient art was renewed. The evolutionary testimonies of collecting come mainly from Italy, particularly in Florence, where the Medici dynasty was the first true promoter of this renewed trend. Classical art was seen on two different points: for artists as a model of inspiration while for the cities governors as an object of self-celebration and prestige. Precisely on this second aspect, the most famous example is represented by the aforementioned Medici family: they wanted to convey a message that would enhance their political and cultural power, together with their intellectual and social prestige. The collections become for the artists themselves a tool to have prestige and social reputation and historians attribute to this period the genesis of art criticism (C. De Benedictis, 1998).

In continuity with Humanism, during Renaissance in Europe the appetite for knowledge increased and Italian museums were at the forefront. According to Murray (1904), museums in the Renaissance showcased Roman coins and medals, engraved gems, and elaborate pieces of art. Noted collectors during this time included Ermolao Barbaro (a naturalist), Cardinal Bembo and Thomas Howard (an English earl). Moreover, the Italian Renaissance improved the museum and the collection concept in an anthropocentric perspective, in which the man was considered the architect of his own fortune.

This cultural transformation influenced the whole art in Europe, as in France, where Francis I of Valois exhibited in the Fontainebleau castle some works of the greatest Italian artists of the Renaissance, among which Leonardo da Vinci, Michelangelo and Tiziano. In Germany, characteristics of that period were also the "Cabinets of Wonder" or in German "Wunderkammer", consisting of private collections of rare and particular exhibits (like corals, fossils or minerals). They represented a typical phenomenon of the XVI century, especially in northern Europe, which lasted till the XVIII century inspired by the scientific curiosities typical of the Enlightenment. Benedetto Benedetti (2013) said: *“These are only one aspect of what the development of the modern museum will be, which derives, in its first phase, above all from the organization and opening to the public of private collections of antiques and artistic objects, even rare and precious, by, above all, of popes, sovereigns, nobles and civic institutions.”*

What can be considered the first modern museum in the world was set up in the Rome of the Popes, with the institution of the Capitoline Museums. The historic seat of the Capitoline Museums is constituted by the Palazzo dei Conservatori and, subsequently, by the Palazzo Nuovo, which overlook Michelangelo Piazza del Campidoglio. Its creation can be traced back to 1471, when Sixtus IV donated to the city a collection of important bronzes from the Lateran), which he placed in the courtyard of the Palazzo dei Conservatori and on the Piazza del Campidoglio, creating a real museum venue specially set up to exhibit the donated collections. It can probably be considered the oldest public museum in the world, together with the almost contemporary Belvedere Garden, which was specially set up in the same papal seat to exhibit exceptional works of classical statuary found in the area and also coming from contemporary excavations (B. Benedetti, 2013).

It is during the XVIII century, with the Enlightenment, that the museum gained an important social value. Indeed, the underlying concept was that all men have the right to admire the masterpieces of art, without any social distinction. Therefore, it is during these years that the museum has started to be seen as an instrument capable to support the transformation of the visitor into a model citizen, setting him free from tyranny and ignorance.

After the outbreak of the French Revolution, museums were rethought as public places where the memories of the past should be held. The most symbolic case is represented by the opening of the Louvre Museum in 1793, transforming in a museum the building wing of the former French King residence which connected the royal castle nucleus with the Jardin Tuileries. The history of what is now considered as one of the most popular museums worldwide, dates back to May 1791 the Constituent National Assembly decreed that the Louvre and Tuileries would form the National Palace, intended as the king residence and to house an exhibition of science and arts for educational purposes. The supporters of the idea aimed to demonstrate the superiority of the new regime over the

old, which in previous decades had failed to complete the transformation into a museum, and to make Paris the capital of the arts and a new Athens. The Interior Minister Roland appointed a six-member commission to oversee the work. Subsequent events contributed to the acceleration of the process, also thanks to the confiscation of works of art from the Church and the émigrés. In April 1793, Roland was succeeded by Garat and the museum opened its doors on 10 August 1793, on the occasion of a festival to celebrate the first anniversary of the Republic. From November of the same year, it was officially "*Muséum central des arts de la République*" (A. McClellan, 1994).

Meanwhile, other public museums were opened as well across Europe, it is worth to mention the British Museum in London inaugurated in 1753 and the Uffizi Gallery in 1737, as a donation of Anna Maria Luisa de' Medici to the citizens of Florence in 1737.

With the beginning of the XIX century, Europe faced the so-called "Napoleon's art-loot", a series of theft of assets, in particular works of art (and in general of precious works), carried out by the French army (or by Napoleonic officials) in the territories of the First French Empire, such as the Italian peninsula, Spain, Portugal, the Netherlands and Belgium, Central Europe, but also Egypt. The concept behind the actions of the French Empire was that such an important cultural heritage must have been held and showed only in the Country of Liberty (i.e. France). During the first years of this century, the Louvre became the largest and most spectacular art museum in Europe. Thanks also to an architectural revolution, works of art were divided into deposits and rooms, rationalizing spaces and decorating them in a uniform way and set up according to precise criteria of exposure, exploiting the natural sunlight to enhance their characteristics. The artworks were selected, restored and classified according to the period they belonged to, and they were exhibited with a short text guide in order to provide the visitors some knowledge about the piece under observation.

During the second half of the XIX century, the birth of American museums introduced changes in the way of thinking and approaching a cultural institution. They were born mainly from private donations and from the exhibitions of large industrialists interested in artworks both as a form of investment and as a way to gather social prestige (L. Binni, 1980). "*American museums rejected the classical European vision, using rough constructions like former warehouses as exhibition sites. In addition to this, it was explicit from the beginning that their didactic orientation was used to emphasize local pride, putting the responsibility of museums and their management in the hands of civic institutions, to the detriment of a universalistic view*" (G. Beretta & L. Pirti, 2019). It is in the second half of this century, that the concept of "company-museum" was introduced. This idea has influenced the entire world, cultural institutions began to be considered as entities to be managed in an entrepreneurial way, becoming entertainment venues focused on contemporary interests and trends, with also a learning offer for visitors. It is in these years that the concept of museum was accosted to

entertainment: “to amaze, to amuse, to intrigue, to create a show become shared choices also for educating” (P.C. Marani, 2006). Remarkable examples are the Metropolitan Museum in New York, the Museum of Fine Arts in Boston and the museums of Philadelphia and Chicago.

With the advent of the XX century, museums started to embrace all the other manifestations of contemporary culture, such as photography, architecture, industrial design and movies. During the middle of this century, other two themes arose influencing the perception of the museum: the central role of the visitor and the typology of the building in which the museum is held. The main question was whether the museum architecture should remain neutral to emphasise the contents under exhibition, or if it had to play a central role in attracting and welcome the audience. Mies Van Der Rohe and Frank Lloyd Wright were the exponents of the two principal opposite currents of thought: according to the German architect, the museum was a simple container, that should not interfere with the artworks exposed (V. Magnago, 2001). Wright, instead, believed that the building architecture should be the centre of attention, as expressed by the Guggenheim Museum in New York, projected by him in 1943. Another conceptual advance regarding museums happened in 1977 in Paris with the Center National d'Art et de Culture Georges Pompidou, a project by Piano and Rogers. The challenging objectives were mainly two: on the one hand, to create a complex characterized by maximum flexibility, on the other hand, to relate it to the surrounding urban space.

Finally, the realization of the concept of putting the visitor at the centre of the cultural experience is conceived with the virtual museum. *“During the current century, thanks to the latest technological developments, virtual museums have radically changed the visit experience: starting from text and images with limited interactivity, they have moved to a consolidated multimedia presence, usable also by different mobile devices such as mobile phones or tablets. Thanks to these technological tool, virtual museums can exist without corresponding to a physical location”* (G. Beretta & L. Pirti, 2019).

Concluding, it is observable a shift from an object-oriented conception in which the Museum is a sacral place of knowledge and culture, to a customer-driven approach in which the Museum is perceived as an organization to be managed, that proposes a value to the public. Figure 6 below synthetizes this, proposing a timeline regarding Museum historical evolution.

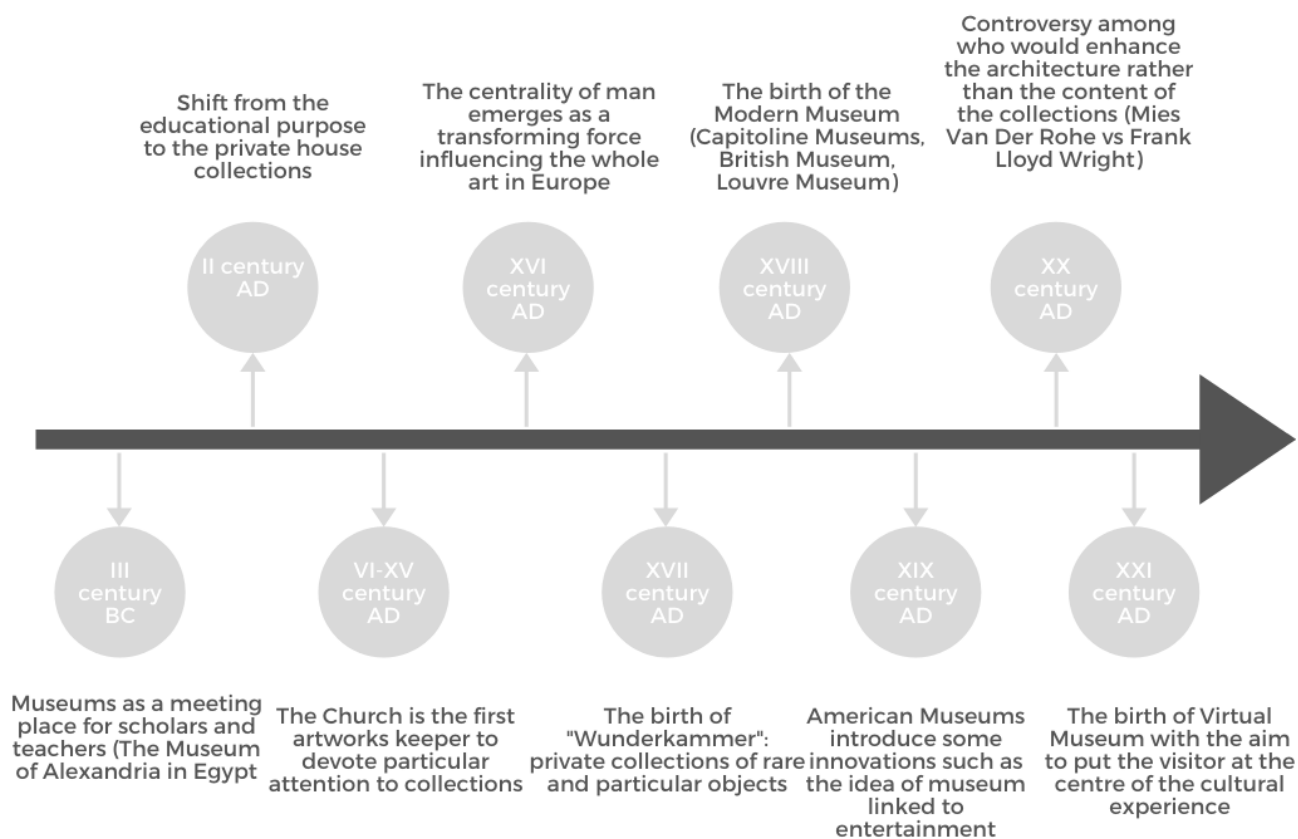


Figure 6: Evolution of cultural institution in history (G. Beretta & L. Pirti, 2019)

2.1.2 Museums and collection definitions

What is now provided, is a clear definition and contextualization of museums, with reference to International Council of Museums (ICOM). ICOM is a membership association and a non-governmental organisation which establishes professional and ethical standards for museum activities. As forum of experts, it makes recommendations on issues related to cultural heritage, promotes capacity building and advances knowledge. ICOM defines itself as *“the voice of museum professionals on international stage and raises public cultural awareness through global networks and co-operation programmes”*. It operates in 138 countries and counts 44,686 professionals, working with 118 national and 32 international committees.

Proceeding in chronological order, the first definition is contained in the 1974 ICOM Statutes, this has been used as a term of reference for over thirty years and stated: *“A museum is a non-profit making, permanent institution in the service of society and of its development, and open to the public, which acquires, conserves, researches, communicates and exhibits, for purposes of study, education and enjoyment, material evidence of people and their environment.”*

Going further, the ICOM 2007 sentence replaces the first statute related to 1974, even though there is just one substantial. Indeed, in the latest version a reference to intangible assets has been added. The structure of the 1974 definition has the same words of the 2007 version, but with a different order. Furthermore, the eldest definition emphasized the function of research, presented in some way as the driving principle of the institution, while in the 2007 version this principle is relegated to the general function list of the museum. Consequently, as presented in the ICOM's Statutes of 2007: "*A museum is a non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits the tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment.*"

However, it is of December 2018 the decision by the Executive Board of ICOM to enter a process of a possible revision of the Statute. According to the Executive Board, the definition of Museum should:

- *Be clear on the purposes of museums:* and on the value base from which museums meet their sustainable, ethical, political, social and cultural challenges and responsibilities in the XXI century;
- *Retain the unique, defining and essential unity in museums of the functions of museums:* such as collecting, preserving, documenting, researching, exhibiting and in other ways communicating the collections or other evidence of cultural heritage;
- *Acknowledge the urgency of the crises in nature:* together with the imperative to develop and implement sustainable solutions;
- *Acknowledge and recognise with respect and consideration the vastly different world views:* these are the conditions and traditions under which museums work across the globe;
- *Acknowledge and recognise with concern the legacies and continuous presence of deep societal inequalities:* together with asymmetries of power and wealth across the globe as well as nationally, regionally and locally;
- the museum definition should express the unity of the expert role of museums with the collaboration and shared commitment, responsibility and authority in relation to their communities;
- *Express the commitment of museums:* they have to be meaningful meeting places and open and diverse platforms for learning and exchange;
- *Express accountability and transparency:* conditions under which museums are expected to acquire and use their material, financial, social and intellectual resources.

The active use of collections is a key point when dealing with the meaning of museums, indeed, “it is through collections and the way they are used to deliver cultural experiences that museums give benefit to the public” (H. Wilkinson, 2005). Referring to collections, the scholars F. Desvallées and A. Mairesse (2009), define it as "a set of material or immaterial objects (works, artefacts, archival documents, testimonies, etc.) that an individual or an organization has taken care to collect, classify, select, make it safe and, often, to communicate to a wider public, depending on the nature of the collection, public or private". A further contribution is provided by K. Pomian (1987): “any set of natural or artificial objects, temporarily or permanently maintained outside the circuit of economic activities, subject to special protection in an enclosed area arranged for this purpose and exposed to the public’s eye”. In this second case, the symbolic value is emphasized, putting collection usefulness or its exchange value in second place. Nevertheless, having it material or immaterial value, the collection is at the centre of the museum activities and ICOM agreed with this: "museums have a duty to acquire, conserve and enhance their collections in order to contribute to the preservation of the natural, cultural and scientific heritage" (ICOM, 2006). In order to build a collection, it is necessary that these objects are aggregated to create something meaningful and that is worth to visit. This leads to distinguish between collection and fund. Indeed, in the second case, there is not a real selection of objects, which are cobbled together without a coherent logic behind. A list of the definitions presented is reported below in Table 4 (G. Beretta & L. Pirti, 2019).

Authors	Definition	Topic	Academic vs Practitioners
Maroevic (2007)	The museum institute is a materialized form of the museum institution	Museum	Academic
ICOM (2007)	A museum is a non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits the tangible and intangible heritage of humanity and its environment, for the purposes of education, study and enjoyment	Museum	Practitioner

ICOM (2006)	Museums have a duty to acquire, conserve and enhance their collections in order to contribute to the preservation of the natural, cultural and scientific heritage	Museum	Practitioner
Desvalées & Mairesse (2009)	A set of material or immaterial objects (works, artefacts, archival documents, testimonies, etc.) that an individual or an organization has taken care to collect, classify, select, make it safe and, often, to communicate to a wider public, depending on the nature of the collection, public or private	Collection	Academic
Pomian (1987)	Any set of natural or artificial objects, temporarily or permanently maintained outside the circuit of economic activities, subject to special protection in an enclosed area arranged for this purpose, and exposed to the public's eye	Collection	Academic

Table 4: Definitions of museum and collection in literature (G. Beretta & L. Pirti)

For sake of precision, in order to conclude it is necessary to point out that the museum is an institution not deeply defined: both in the case of public museums and private museums, it is not regulated by an organic set of rules related to its specific mission. Indeed, there is no normative that uniquely identifies museums and similar institutions, nor an official list that identifies these structures nor a homogeneous certification system for evaluating the technical-scientific standards that describe their operation.

Moreover, the word “institution” is often used as a synonymous of “museum” when it is preceded by the adjective “cultural”; it is different from the term "institute" which is instead specific and concrete: *"the museum institute is a materialized form of the museum institution"* (I. Maroevic, 2007).

2.1.3 Museums perception in modern ages

This Section provides a series of further Museum definitions and thoughts by scholars belonging to different fields. These have been considered and reported in order to amplify the perspective as regards cultural institutions.

If the previous Section discussed the evolution of the concept of Museum in the centuries, the focus here is moved on the modern idea of it, quoting the former curator of the Poldi Pezzoli Museum in Milan, Maria Teresa Balboni Brizza (2000): “*Today, nobody thinks the museum as the place of the muses. All have forgotten Ptolemy I and the building he founded in Alexandria, intended as a centre of study and activity for artists. Everyone knows what a museum is. And everyone keeps trying to define it*”. Therefore, hereby are presented the following additional considerations:

- *Museums and education:* to this extent, the Dutch museology and cultural heritage expert, Peter Van Mensch (1992) defines the Museums as “*a permanent institution, which preserves collections of material documents and produces knowledge from them*”. In addition, it could also be defined as a “*place out of memory*” (P. Nora, 1984; G. Pinna, 2003), that is used in order to provide public with evidence of something that has belonged to a previous time. In this sense, the process continues beyond that space and time, spreading the message and keeping its memory alive. As a matter of fact, the term Museum can even mean “*a phenomenon, which incorporates different places or territories, experiences and even immaterial spaces, where the things and the values related to them are preserved, studied, and communicated as signs to interpret absent facts*” (M.R. Schärer, 2007).

Museums are also a fundamental presence for supporting learning, “*especially informal, family and life-long learning; as a social and recreational space; and for shaping a sense of self and society through preserving cultural heritage and building understanding of other cultures*” (B. Usherwood, 2005). Recalling the traditional conception of museums, they can be considered as centres of culture and curatorial competences, which however have moved over time towards a more and more public-oriented image, becoming tools for helping people to learn about society, culture, history and science, and providing at the same time entertainment (T. Travers, 2006).

Summarising, museums have always had education and culture transmissions as purposes. These have not to be intended as the rigid and scholastic ones, but those that deal with progress and want to bring improvements for the society.

- *Museums as a complex space-time dimension:* according to Balboni Brizza (2000), the Museum interpretation can be broken down into different levels referring to the space-time dimension.

At first level, there are the artworks, which have been realized for a reason and were usually commissioned from other people. It is also common that, before being exposed on the walls of a museum, their ownership changed several times.

The second level is how the artworks have been set up: there is someone which have thought about how to exhibit the work at first time, giving meaning to them; maybe, subsequently, a new curator has changed his mind by modifying the colour of the wall, the caption, or the lighting. If the first level regards the object itself, here the discussion is moved to the way in which it is observed and how someone wants the public to look and think at it.

The last level refers to the people that admire the artworks, tackling the space and time of visitors. Space is not only the physical room in which a person moves, but the term also refers to the interior space in which emotions and amazement arise. This is related to the concept of time, since it takes time to walk through the museum rooms but also to understand, to empathize and get emotional. The objects in the museum are means for transmitting messages that go beyond their physical form, becoming a symbol of something broader because they deal with ages, riches, thoughts, wills and ideas. In light of these considerations, museums can also be defined “*symbolic place*”, being them the keepers of these objects (M.C. Ruggeri Tricoli, 2000).

- *Museums and possible contradictions*: there are scholars that have provided their opinions about the contradictions in which the term Museum might risk being subjected.

Citing the Italian paleontologist Giovanni Pinna: “*Most of the time, the museum is used, unconsciously or not, as a tool for mystifying objective realities and manipulating the interpretations of history*” (G. Pinna, 2003). According to him, a museum might become a place of sham because, due to the objects decontextualization (moving them away from their original environment and placing them in an artificial one), it might generate situations that are not relevant to reality in which the object was conceived and realized. This brings to the elaboration of subjective meanings, which do not communicate absolute truths, but just relative ones. Pinna states that, most of the times, what is offered to the public is a manipulation of reality, both conscious and unconscious, because an absolute representation of it results impossible and it is often substituted with representations for secondary interests. Even if Pinna recognizes the extraordinary value of an institution like the museum, he also warns about the process of manipulating things, with the aim to convey a message. According to Pinna, if on the one hand the institutional role of museums and its authority are recognized of great value, on the other hand these, together with an intrinsic subjectivity, make museums powerful tools for manipulating memory, history or identity. The danger lies in the non-neutrality of the operation, in the sense that everything is realized with an interpretation or a communicative will.

Continuing in this direction, Adalgisa Lugli also states: “*The museum as an abstract place from reality, completely alien to the mechanisms of production and usage of the objects that characterize everyday experience. It does not want to be a place of abstraction but, in reality, it has become an environment in which superficial knowledge is transmitted and received. It is a market of illusions*” (A. Lugli & V. Vercelloni, 2004).

Lugli and Vercelloni do not think that the museum deceives because of the manipulation of the message that it is aimed to transmit, but because this does not coincide with the reality by nature. Indeed, despite what the museum conserves is real and has belonged to a past reality, by extrapolating objects from their actual context and placing them in a new one, the museum alters information, creating a parallel reality that has no points in common with the original one. They also reflect whether the museum can be against the law of nature, being it created to preserve things that, in the natural course of the events of the world, would be destined to corrupt and disappear. However, the museum wants to preserve them immobilizing them in a given time and place.

2.1.4 Museums classification

Museums are commonly classified on the basis of the collections collected and exhibited to the public. Currently, however, there is no single and unambiguous way of classifying Institutes. This determines the need, when a field study is carried out, to choose which modality to adopt. The well-known UNESCO classification system of 1984, also applied by the European Group on Museum Statistics (EGMUS), divides museums into nine classes based on the prevalent nature of the objects on display:

1. *Art museums*: which exhibit works of art and applied art;
2. *Museums of History and Archeology*: which aim to present the historical evolution of one region, area or province for a limited or long-term period;
3. *Museums of history and natural sciences*: which exhibit objects related to one or more disciplines such as biology, geology, botany, zoology, paleontology, ecology;
4. *Museums of science and technology*: connected to one or more exact or applied sciences such as astronomy, mathematics, physics, chemistry, medicine, construction industries, articles and manufacturing. This category also includes planetariums and science centres;
5. *Museums of ethnography and anthropology*: which present materials on culture, beliefs, costumes and traditional arts
6. *Specialized museums*: interested in researching and presenting all aspects of a single theme or subject not included in the previous categories;

7. *Territorial museums*: which illustrate a more or less extensive territory such as to constitute a historical-cultural and sometimes even ethnic, economic or social entity, whose collections are shared by a specific territory;
8. *General museums*: which possess mixed collections and cannot be identified from a main area;
9. *Historical monuments and archaeological areas*: such as architectural or sculptural works and areas of particular interest from the archaeological, historical, ethnological and anthropological point of view;
10. *Zoological gardens, botanical gardens, aquariums and nature reserves*: which are characterized by the specificity of presenting living species.
11. *Other museums*: not included in any of the other categories.

Instead, EGMUS keeps a similar logic, but limiting the categories in which museums can be grouped to just three:

- A. *Museums of art, archeology and history*: which includes Art Museums and Museums of History and Archeology;
- B. *Scientific, technological and anthropological museums*: which include museums of history and natural sciences, museums of science and technology, museums of ethnography and anthropology;
- C. *Mixed museums*: which consider specialized, territorial, general and other museums.

This classification is generally applied in Italy by ISTAT (which however does not consider science centres as museums, as they do not contain collections) together with the proposed subdivision based on the owners, identifying:

- Public, state, ministerial, university, regional, provincial and municipal owned museums;
- Private museums, owned by private entities such as ecclesiastical bodies, foundations, associations, private individuals, cooperatives, families, individuals;
- Museums in mixed form, which belong together to a public body and a private body.

In the most recent surveys, slightly deviating from the previous classifications, ISTAT identifies only eight categories of museums based on the nature of the objects on display: museums of art, archeology, history, natural history and natural sciences, science and technology, of ethnography and anthropology, territorial, specialized. The definitions assigned in these surveys from ISTAT to the categories of interest for this study are:

- *Natural history and natural science museums*: collections of non-living species, minerals or fossils, organized for public display;
- *Science and technology museums*: collections of machines, tools and models, including related projects and drawings.

Other well-known classifications are that proposed by the French Museologist Georges Henri Rivière, who suggested the division into four groups (art museums, human science museums, natural science museums, science and technology museums), and the tripolar distribution of Gary Edson and David Dean, which is articulated around the poles of art, history and science. Cataldo and Paraventi (2007), on the other hand, propose a differentiation divided into 33 categories identified on the basis of their content, or the typology of the objects preserved. The categories indicated by the Authors are: academy, antiquarium, armory, intaglio, house-museum, eco-museum, cabinet of drawings and prints, gallery, gallery of modern art, plaster casts, glyptothek, lipsanoteca, archaeological museum, anthropological and ethnographic museum, art museum, industrial art museum, jewelery museum, landscape museum, territory museum, business museum, naval museum, numismatic museum, museum of prehistory, science and technology museum, specialized museum, history museum, museum of history and natural sciences, virtual museum, palace or residence-museum, park-museum of open-air sculpture, picture gallery, picture gallery.

2.1.5 Museums and value generation

This Section presents a short analysis about the main sources that might generate value for cultural heritage institutions, in order to obtain further insights about their operating context.

In addition to the main role of heritage preservation, cultural institutions can focus on achieving different goals, in terms of both artistic and creative contents, but also looking at audience engagement and social impact. As pointed out by Bakhshi, and Throsby (2009), this variety of objectives is reflected in an observed heterogeneity of financial structures. Such structures differ according mainly to the source of museums funds, which may come from the public sector, private sources or generated through the museums own activities. The latter element includes several additional incomes, among others admission charges, the gift shop, or food service (ICOM, 2004).

In the end, it is the particular combination of the three above mentioned fund sources that determines the financial structure of the single institution. This might bring issues when trying to model in a general sense the economic behaviour of museums. However, as presented in Section 2.1.2, museums are by definition non-profit institutions, for which it is then possible to apply the basic theory of not-

for-profit firms to cultural institutions when carrying out an economic analysis of these institutions (D. Throsby, 2001).

As non-profit organizations, the principal purpose of cultural institutions should not be the maximization of shareholders value in a direct financial sense (H. Bakhshi & D. Throsby, 2009). Moreover, the museum is usually considered as a patrimonial asset and not as an economic instrument able to generate significant cash flows. This aspect also relates to the lack of interest about museums accountability systems and practices of planning and of management control, which often remain at an elementary level (Aspen Institute Italia, 2012).

Despite this, nowadays museums are encountering a growing need to prove that they are able to contribute to the society with a form of particular value generation (A. Bollo, 2013). Even though the measurement of this presents several difficulties due to its various character, the Netherlands Museums Association has identified five values (DSP-groep, 2011) that together highlight the social significance of these institutions (A. Bollo, 2013):

- *Collection Value*: is at the heart of a museum existence and encompasses a wide range of values related to its collection, conservation, management and display activities;
- *Connection Value*: depends on the museum's ability to act as a networker and mediator between the various groups of society (giving coherence to current topics and issues through relevant and significant contexts) and to become an ideal platform for communication, debates and to enter into partnership with different stakeholders;
- *Education Value*: lies in the museum ability to propose itself as a (formal and informal) learning environment for a broad range of people. Museums can serve as schools in a literal sense as well: for young people to complete work placements, for adults who want to nurture their interests, for academics to conduct research;
- *Experience Value*: it is related to the museum ability to provide opportunities for fun, experience and adventure; a place of inspiration, relaxation and even action, where people can be stimulated both physically and intellectually;
- *Economic Value*: depends on the museum contribution to the economy of a place: the number of tourists that museums attract, the jobs they create directly and indirectly, the capital represented by the thousands of volunteers, museums' appeal to businesses and to families with high levels of education, and the multiplier effects on local income and revenues.

By observing these five points, it is possible to state that not all of value generated by museums can be entirely measured using the economic value, since there are specific characteristics of the cultural

value which cannot be reduced to a monetary form. Moreover, the relationship between cultural and economic value is still under debate: Klamer (1996) states that, when dealing with art and artist, “*The underlying production forces are the same as in other spheres [...] but the means of production are different*”. This, according to the Dutch economist, leads to a mechanism in which the symbolic value overcomes the economic value. Of course, there are also currents of thought which have a more “concrete” point of view and separate the emotional sphere from monetary aspects. An example is provided by Allan et al. (2013), which developed a detailed framework in order to assess the value of artworks and culture in general.

Generally, non-profit organizations sustain high fixed costs compared to the variable costs, with a relatively low level of demand and limited funding. This can be explained by an observed decrease of public budgets, together with a reduction of participation in traditional cultural activities (European Commission, 2014). Consequently, the objective function of museums could be presented as the joint maximization of the level of output and its quality, subject to a break-even budget constraint (H. Bakhshi, & D. Throsby, 2009). The first term concerns access objectives (i.e. attracting the largest number of visitors as possible); while the latter refers to artistic-curatorial quality standards, together with proposing the audience a valuable collection.

It is possible to conclude this brief analysis by mentioning the main stakeholders to which a cultural institution is aimed to produce the previous discussed value. To this extent, three main categories of stakeholders have to be mentioned (S. Baia Curioni, 2008):

- *Public authorities*: this term includes institutions such as the state, regions and other local authorities. With respect to them, museums are responsible for protecting the cultural heritage "public good" in its various components. The concept is quite broad and can be included within the definition of "public value", which considers the value of public organizations (Keaney, 2006). As said before, the value generated in this case cannot only be reconducted to a monetary dimension but can be extended to intangible components as the above mentioned “Connection”, “Experience” and “Education” values.
- *Scientific and professional communities*: since a museum has the responsibility to guarantee a proper scientific, technological and cultural treatment of the patrimony under management, it is necessary that a strict contact with the scientific and professional communities (historians, curators and technologists) is maintained. These are in charge of defining the quality standards for the actions of protection, conservation and enhancement. The actions related to these communities influence their reputation and judgment in the national and international field, influencing also their ability to acquire resources (for exchange of experiences, loans, co-productions, etc.).

- *Individuals*: this broad category includes all those who are oriented towards a value generated by a direct or indirect relationship with the good in a utilitarian and typically economic perspective. Therefore in this category are included: the visitors (with all the related possible segmentations), the private individuals who indirectly benefit from the proximity of the heritage (owners of neighbouring properties, of catering services and of hotels), the sponsors who act for utilitarian reasons (support of brands and products, incentive policies for customers, staff and suppliers), the customers of business-to-business services, such as companies that relate to the museum for freight charges on spaces, images and brands and, finally, the employees.

2.1.6 Museums Value Chain

If the previous Section presented a description of the multifaced value generated by museums, the current one is aimed to carry out an analysis of how such value is created. In order to do this, the concept of Value Chain has been exploited.

The Value Chain (Figure 7) was firstly introduced by Michael E. Porter in his 1985 book “*Competitive Advantage: Creating and Sustaining Superior Performance*”, in which it was described as a set of activities that an organization has to perform in order to create value for its customers, which is the fundamental purpose of any entity. The competitive advantage of a business resides in these value activities, modelled as they were “discrete building blocks”.

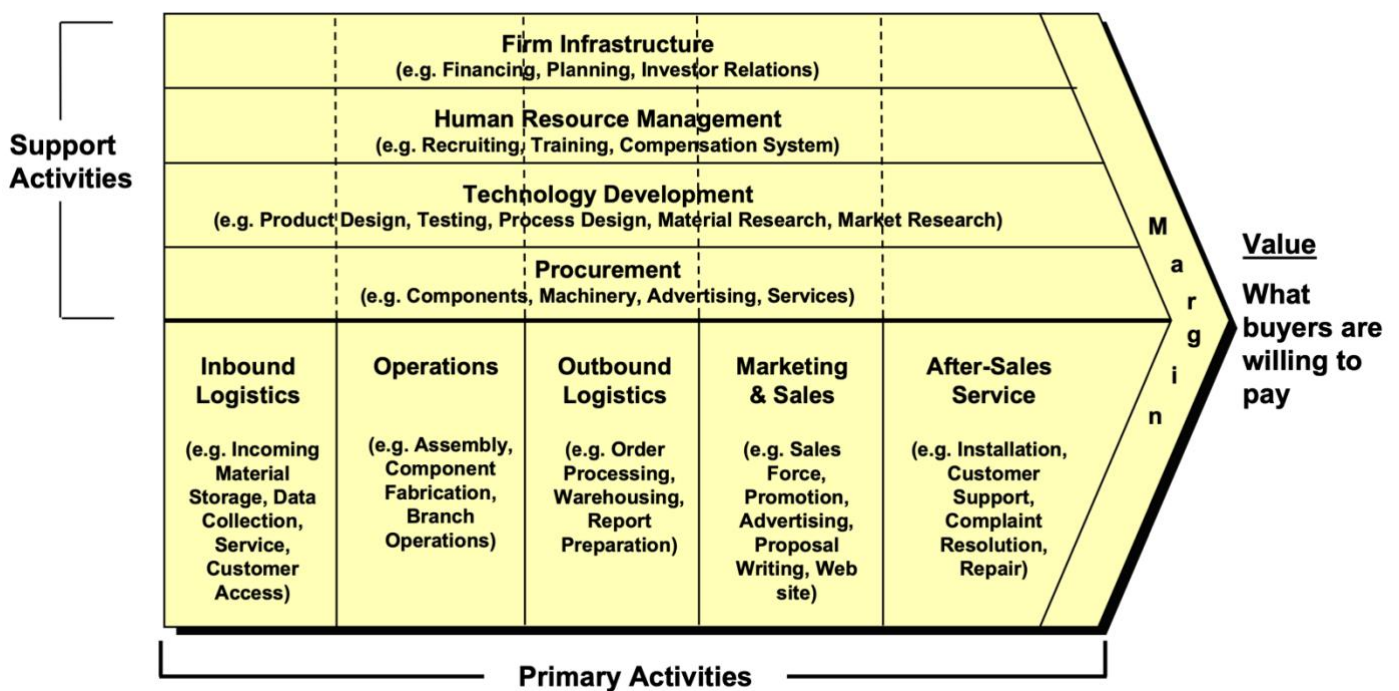


Figure 7: Porter Value Chain (M.E. Porter, 1985)

According to Porter, value activities are of two main types:

- *Primary activities*: are those that directly contribute to the creation of an organization output (products and services), to its sale and transfer to the customer, as well as the after-sale assistance;
- *Support activities*: are those that do not directly contribute to the creation of the output but are necessary for it to be produced.

However, when trying to adapt it to the typical activities of a cultural institution, some difficulties arise, and this process is not immediate. It has been Porter himself that, in a 2006 publication named “*Strategy for Museums*” addressed to the American Association of Museums, rethinking the concept of Value Chain in order to make it fit with the particular case of museums. The resulting model is showed in Figure 8.

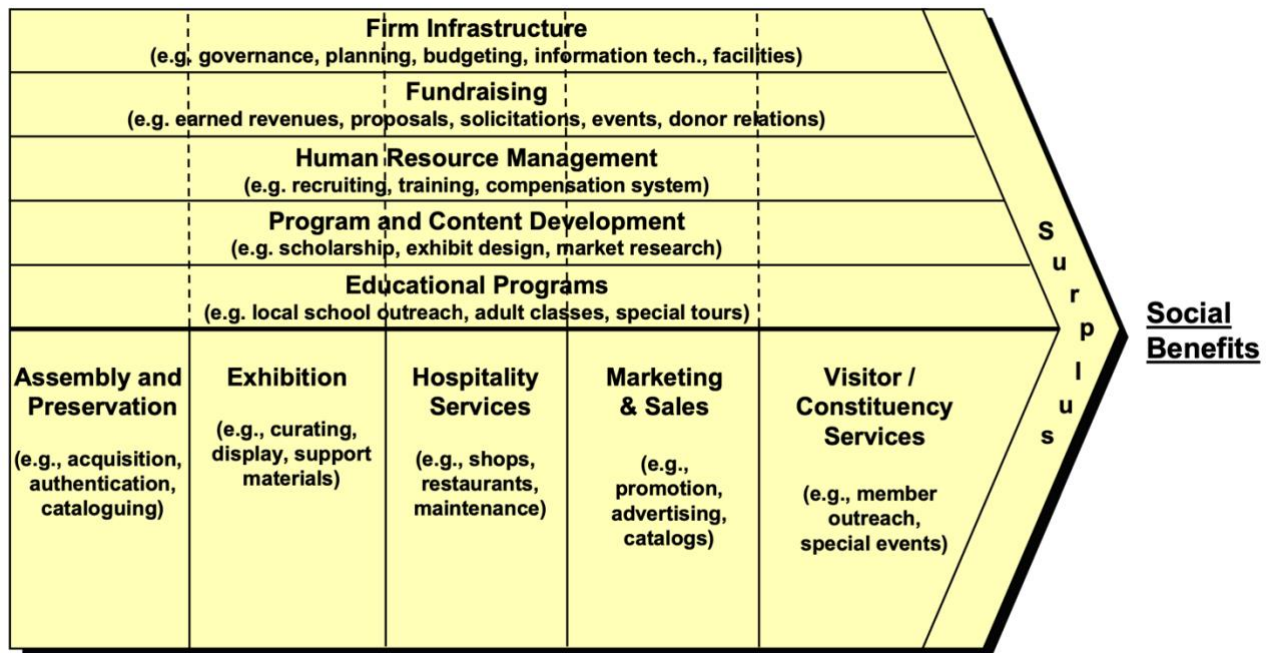


Figure 8: The Museum Value Chain (M.E. Porter, 2006)

In this new framework, ten strategically important activities that museums have to carry out are identified, each one of them being a source of value and of cost. According to Porter, the primary activities for museums concern the acquisition of cultural heritage for its preservation and further exhibition and communication to the community. To support these activities, processes regarding the infrastructure, the human resources, the financial aspect, the content and the educational programs, must be held.

The museums surplus will depend on the effectiveness and efficiency of these activities which, at the same time, will depend on the value museums are able to deliver to their visitors. It is necessary to

notice how, when analysing these particular institutions, Porter does not define the value generated in financial terms but rather as “social benefits”, a term which includes customer value, community outreach, and public service. This approach is consistent with the five types of value identified by the Netherlands Museums Association, that were described in the previous Section. A correct business model identifies what customers value and organizes its own activities based on it. This is the way through which museums can achieve a competitive advantage and obtaining the best performances in their market (N. Kotler, P. Kotler & W. Kotler, 2008).

Besides Porter, the authors Normann and Ramirez (1993) stress the importance of the customers as well, even though they propose a shift of perspective: instead of considering sequential value activities, they propose a value-creating system in which there are different stakeholders (suppliers, partners, customers) positioned in a “constellation”, which contribute to the value production. Their thesis is that successful companies do not just add value through their operations, but they “reinvent” it according to stakeholders needs. As regards business entities, according to the authors: *“Their key strategic task is the reconfiguration of roles and relationships among this constellation of actors in order to mobilize the creation of value in new forms and by new players. And their underlying strategic goal is to create an ever-improving fit between competencies and customers.”* This is also coherent with what said in the previous Section, when identifying the museums main stakeholders (S. Baia Curioni, 2008). Ferraro (2011) said that: *“There is a lively international debate discussing the “growing visitor orientation” of public museums [...] museums have shifted from collections to audiences. As a result, public museums today are perceived as an amalgam of a series of both tangible and intangible multi-sensory experiences and are becoming a multifunctional cultural centre, directly competing on the convergent art, cultural and leisure markets, by providing a full range of facilities and services, ranging from traditional showcasing of cultural heritage objects to interactive educational services, art performances, commercial products, ateliers, etc.”*

There is another version of the value chain model which incorporates explicitly the presence of different actors as well. This was proposed by Bakhshi & Throsby in 2009, in a research report made for Nesta (Figure 9). The latter, *“is a global innovation foundation, based in the UK, which supports new ideas that tackle the challenges society is currently facing. It operates in different fields, among which creative economy and culture, education, public administration and health, collaborating also with the United Nations and the European Commission”* (A. Balzano, 2019).

It can be observed that beyond the cultural institution, the authors considered also the customers, the funding bodies and the artists. Furthermore, the interactions between the several actors are presented, differentiating between production, distribution and consumption of artistic content on the one hand, and the flow of content, services and money on the other. It is worth mentioning how this presented

subdivision follows almost perfectly the operations described in ICOM definition of a Museum as an organization that “[...] *acquires, conserves, researches, communicates and exhibits* [...]”.

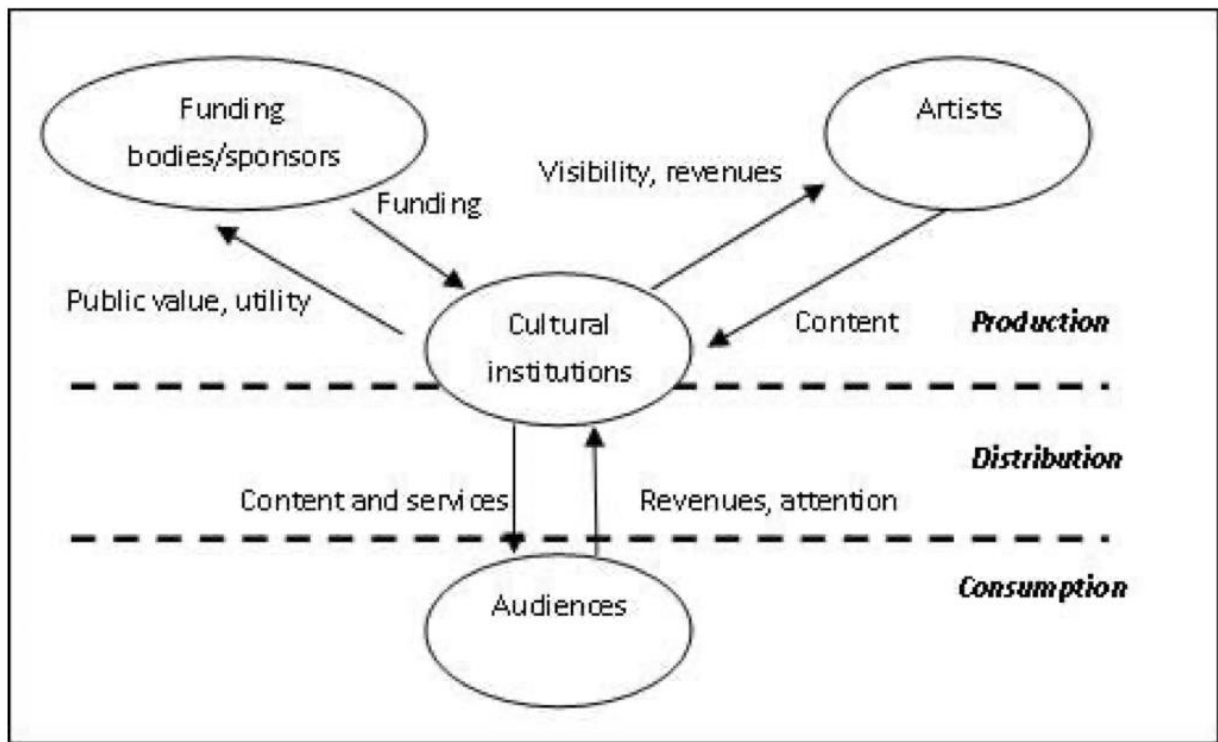


Figure 9: Nesta Value Chain for cultural institutions (H. Bakhshi & D. Throsby, 2009)

The last model reported in this Section is the one proposed by Ferraro in 2011. In this framework, Ferraro integrates the traditional and well established museal activities (conservation, display and service) with new directions in museum management. The latter refers to the alignment of museums strategy to co-production, governance and new learning and entertainment opportunities, together with a shift towards becoming a place for multi-sensorial experiences. To successfully achieve this integration, Ferraro museal value system combines elements extracted from different sources and authors including, among others, Porter Value Chain, ICOM standards, ICOM Code of Ethics and the Italian legislative Decree n.112/98 (which concerns the Conferral of administrative functions and tasks of the State to the regions and local authorities). Briefly, by identifying four main clusters of museum activities, this framework integrates successfully several models and captures both traditional museum activities with new trends like customer participation and the importance of networking (A. Balzano, 2019). These activities are hereby listed and are also observable in Figure 10:

- *Research and Conservation*: this area concerns the most traditional museal functions and groups the activities related to “making and maintaining collections”, i.e. the acquisition, documentation and conservation of heritage;
- *Valorisation and Communication*: it comprehends all the range of activities contributing to qualify the visit experience and the perceived museum value. This group represents the integrated system of museal offer;
- *Support Activities*: this cluster includes all the strictly instrumental activities: human resources management, planning and control, fund management, ICT;
- *Networking and Governance*: networking has proved to be of primary importance for museum survival. This cluster identifies the systemic dimension of museum management, encompassing all the activities relevant for museum offer integration, governance and functional integration.

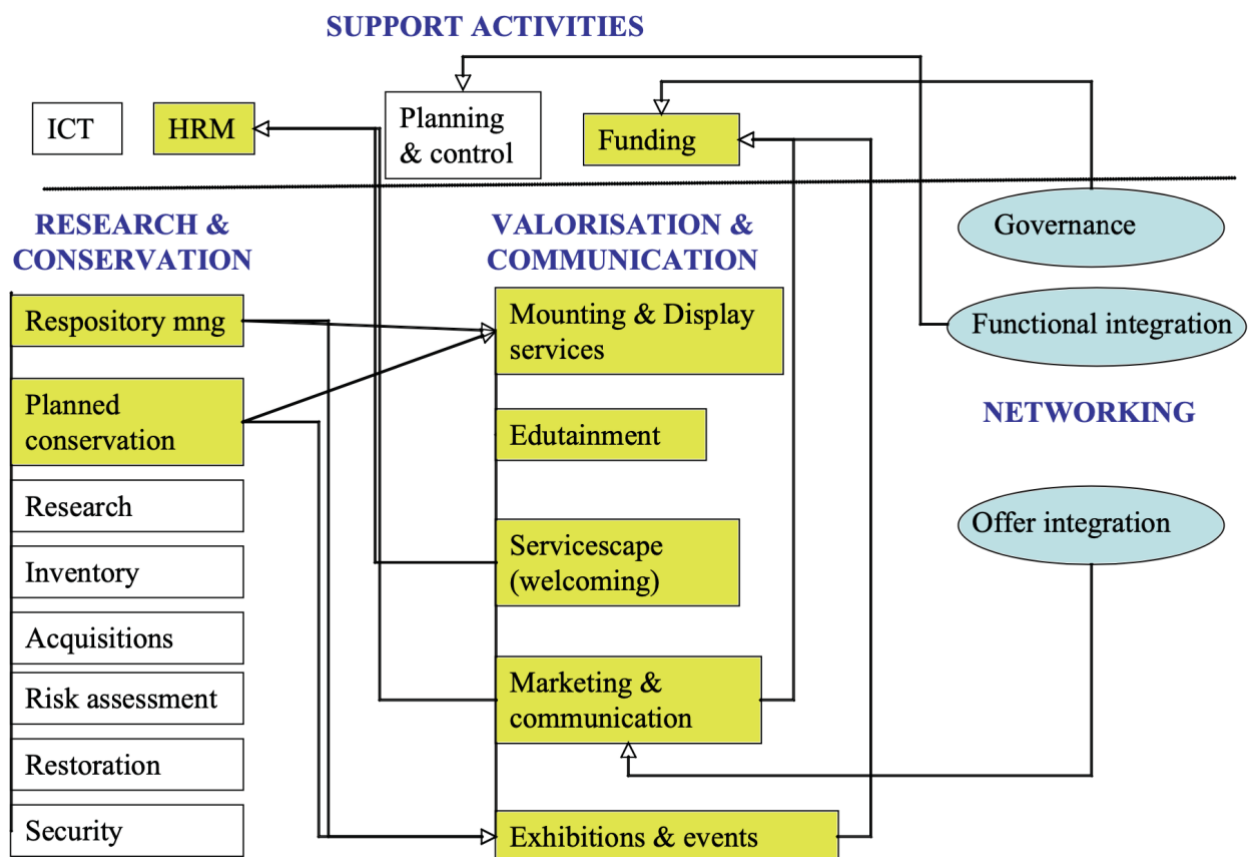


Figure 10: The museum adapted Value Chain model (V. Ferraro, 2011)

2.2 Insights on the three collaborating institutions

After an analysis on a high level about the meanings and the history behind museums, this Paragraph presents a lower-level point of view. Indeed, the perspective is now entirely shifted on the Italian museums scenario, in order to familiarize with the environment in which the three collaborating institutions operate.

As regards their organization, Italian museums have undergone several changes in the latest years. In 2014, the regulation of the Ministry of Cultural Heritage and Activities and Tourism was established, with the Decree of the President of the Council of Ministers no. 171 initiating a reform of the organization and administration of state museums which today, through subsequent amendments up to the Decree of the President of the Council of Ministers 2 December 2019, no. 169 and the Ministerial Decree of 28 January 2020, no. 22, identifies a system coordinated by the General-Directorate of Museums, made up of 40 museum institutes with special autonomy and by 18 Regional Museums Directorates operating in the area, to which all the other museums refer. For better understanding the purposes of the General-Directorate of Museums, it is possible to directly cite its mission: *“The Directorate-General of Museums aims to favour research and the dissemination of knowledge on the Italian cultural heritage kept in museums and presented in cultural places, in order to share their values and originality with the rest of the world. It works to ensure complete access to and use of cultural heritage, monitoring the efficiency and quality of the services available to the public. [...] It promotes innovative management systems, including interactive elements, for museums and cultural places. It plans the future through the conservation of heritage and promotion of creativity, the quality of life and the cultural diversities present on the territory.”*

The Regional Museums Directorates originate from the Regional Museum Centres, established on the basis of the Decree of the President of the Council of Ministers of 29 August 2014, no. 171, in force since 11 December 2014, for the management of museums, institutes and archaeological areas that previously were under the responsibility of other offices. The museum poles are replaced by the territorial directorates of the museum networks, established by the Decree of the President of the Council of Ministers of 19 June 2019, no. 76, in force since 22 August 2019, which in turn have merged into the regional museum offices, established by the Decree of the President of the Council of Ministers 2 December 2019, no. 169, effective from 5 February 2020.

The Regional Museums Directorates are a peripheral articulation of the Directorate General for Museums, with the task of ensuring in the area of competence *“the performance of the public service of use and enhancement of the Institutes and places of culture delivered to the State or the State in any case entrusted to management”* (Decree of the President of the Council of Ministers 2 December

2019, no. 169). In carrying out these functions, the Management defines the strategies and common objectives of enhancement, promotes the integration of the cultural paths of use and, in conjunction with the Regional Secretary, of the consequent tourist-cultural itineraries.

As regards museums with special autonomy, the first 20 institutions belonging to this category were identified in the Decree of the President of the Council of Ministers of 29 August 2014, no. 171, in force since 11 December 2014. To these, 10 additional institutions were added with the Ministerial Decree of 23 January 2016, no. 43 following other amalgamations and modifications determined by the Decree of the President of the Council of Ministers of 19 June 2019, no. 76, in force since 22 August 2019. In the Article 33 of the Decree of the President of the Council of Ministers 2 December 2019, no. 169, there are 40 museum institutes endowed with special autonomy, including *"museums, archaeological parks and other cultural sites of significant national interest"*. Of these, 11 are executive-level offices and 29 are non-general level offices.

Museums with special autonomy are endowed with scientific, financial, accounting and organizational autonomy and consist of the following bodies: the Director, the Board of Directors, the Scientific Committee and the Board of Auditors. The top bodies provide the performance of the museums mission, the cost-effectiveness, efficiency and effectiveness of the activities and check the scientific quality of the cultural offer together with the practices of conservation, use and evaluation of the goods delivered to the museum. The composition of the collegiate bodies is determined in compliance with the balance between genders.

In this context, it has been noted that in recent years the theme of leadership has been particularly evident, based on the figure of the museum Director, *"to the point that, in Italy, a large part of the population and a surprisingly large number of operators of the communication system know their names, a unique circumstance in Europe and, perhaps excluding Russia, in the world"* (A. Mottola Molino, 2004).

Institutes with special autonomy functionally report to the Directorate General for Museums. The list of museums, archaeological parks and other institutes with special autonomy and of the museum institutes related to them is published in the Ministerial Decree of 28 January 2020, no. 22. All of the three northern Italian museums which have requested and contributed to this research project, belong to the first list of 20 special autonomy museums, published in 2014.

In the following Sections, each of the three collaborating institution is taken under analysis, with the aim of providing both historical-geographical and economic-organizational insights. In the light of the just discussed Decrees, being now museums increasingly treated similarly to a business firm, the majority of data is made available and disclosed by the museums themselves. These information are easily consultable on the museums websites.

2.2.1 The Gallerie Estensi of Modena

The Gallerie Estensi are a particular museal institution, constituted of three main locations in northern Italy: Modena, Ferrara and Sassuolo. These sites are historically united by the Este collections that each of them holds. Since 2014, the Gallerie Estensi have undergone a profound transformation. After being listed as one of the twenty museums of national interest, they also obtained the status of Autonomous Museum. In order to better understand the aims of such a particular institution, it is here reported the Vision and Mission declared on their official website: *“Gallerie Estensi’s mission is to conserve, study and enhance the collections in its care for the delight and instruction of the community it serves. The museum sees itself as a vital and inclusive place where visitors can forge a personal and significant relationship with art, encouraging cultural growth within themselves and their city. [...] Gallerie Estensi’s sites testify to the history and culture of a large geographical area. As part of a regional network with a diverse cultural offering, the museums aim to meet the needs and expectations of all its visitors. Overseeing several institutions, the new museum extends beyond physical and administrative geographical border, [...] Gallerie Estensi’s sites therefore, as well as being places for socialising and learning, are sources of delight and continuous exchange between the cities of Ferrara, Modena and Sassuolo, as well as tourist destinations. [...]”*

The museum’s activities will thus be carried out with an eye to the local context, in the sense that it gives voice to a regional cultural identity through exhibitions, events, conferences and activities that appeal to local people.”

The following list reports the three cities which host facilities belonging to the Gallerie Estensi complex. Moreover, for each of the mentioned structures, there are also provided insights and historical remarks:

- *City of Modena:* it has been part of the Este dominions since the XIII century, but it is from 1598 that the city became the capital of the Dukedom of Modena and Reggio, after the forced renunciation of the Este family to Ferrara, which returned under papal control. The court therefore moves to Modena, together with the conspicuous artistic heritage accumulated in previous centuries. However, the Este interest in art and their vocation for patronage did not stop, on the contrary, it regained strength in the new capital.

The Gallerie Estensi themselves declare that: *“We can still enjoy the Este family’s passion for art, books, archaeology and collecting thanks to the collections at the Palazzo dei Musei in Modena, home to the Galleria Estense, Biblioteca Estense Universitaria and Museo Lapidario Estense.”*

Among the remarkable things admirable in Modena, the city places of the Gallerie Estensi certainly occupy a central place: alongside the painting collections, which include valuable

paintings made between the XIV and XVIII centuries, the collections of marble and terracotta sculptures, of objects of applied art, manuscripts, incunabula, geographical and musical maps, as well as archaeological collections from the excavations which, since the XIX century, have brought to light the Roman city of Mutina. The sites belonging to the Gallerie Estensi network located in Modena are:

A. *The Galleria Estense*: established in 1854 by Francesco V of Austria-Este and located since 1894 in the current seat of the Palazzo dei Musei, the Estense Gallery includes four halls and sixteen exhibition rooms dedicated to the conspicuous artistic heritage accumulated by the Dukes of Este since the years of the Signoria of Ferrara.

Oriented towards an aristocratic collecting with multiple interests, the Este collections include the rich picture gallery, which contains a valuable number of paintings from the XIV to XVIII centuries, including a group dedicated to Padana painting, various sculptures in marble and terracotta, a large nucleus of applied art objects that formed part of the ducal wardrobe, as well as various specific collections such as those of drawings, bronzes, majolica, medals, ivories and musical instruments. Among the most important works it is worth to mention the Pietà by Cima da Conegliano, the Madonna and Child by Correggio, the Portrait of Francesco I d'Este by Velázquez, the Triptych by El Greco, the marble Bust of Francesco I d'Este by Bernini and the Crucifixion by Guido Reni.

B. *The Estense Lapidary*: this is the first public museum established in Modena. Its foundation is due to Duke Francesco IV of Austria-Este who, on March 31, 1828, decreed its birth with the name of Modenese Lapidary Museum. It was inspired by illustrious examples such as the Maffei Lapidary Museum in Verona (1738), or the Lapidary Gallery in the Chiaramonti Museum in the Vatican (1800-1823), but with a peculiar civic vocation aimed at glorifying the illustrious past of the city from its origins, as the Roman colony of Mutina. The initial nucleus consisted of some pieces already preserved in the Ducal Palace of Modena, acquired by the Este from other antiquarian collections or as excavated finds from the ducal territories of Brescello and Novellara. Right from the start the citizens, starting with the representatives of the clergy and the nobility, undertook to donate materials of their property and to finance the museum, which in the space of a couple of years registered a significant expansion, certified by the two commemorative epigraphs of its benefactors (from 1828 and 1830) still preserved today. The scientific catalogue published in 1830 by its first director, Carlo Malmusi, set the inspiring principles of the institution: "*to serve archeology for the memory of illustrious ancestors and to study the progress of local sculpture*". In addition to the finds from the Roman age, it immediately welcomed memories and sepulchral arks that for

centuries, up to the late XVII century, have been placed in the churchyard near the southern side of the Duomo or at other sacred buildings in Modena and Reggio Emilia: a practice that arose already in the proto-humanistic era, following the nearby Bologna, in memory of those citizens who have distinguished themselves first and foremost in the field of law and medicine. After the unification of Italy, the Lapidary Museum acquired new spaces under the direction of Arsenio Crespellani, author of a new catalogue in 1897. The latest museum arrangement was that of Cesare Giorgi in 1938, recovered with careful restoration work of the end of the last century.

- *City of Ferrara*: it occupies a special place among the courts that populated the Po Valley in the humanistic and Renaissance periods. The centuries of the Signoria d'Este developed the city starting from the original medieval plan according to the new rational and perspective criteria that became a reference point starting from the XV century.

The city hosts a court where cultural interests are wide and articulated, and this is demonstrated by the patronage of the Este family in favour of intellectuals, writers, theatre actors and artists of great prestige.

As evidence of a great period for Ferrara art, the Pinacoteca Nazionale of Ferrara preserves and offers the visitor a significant review of the painting produced in the city from the XII to the XVIII century, making it one of the attractions of the city.

Housed on the noble floor of Palazzo dei Diamanti, in the rooms including the hall of honour and the XVI century apartment of Virginia de' Medici, the Pinacoteca Nazionale of Ferrara offers a significant review of painting in Ferrara from the XIII to the XVIII century: from the great cycles of medieval frescoes from the churches of San Bartolomeo and Sant'Andrea, to the XVII century paintings by Scarsellino, Carlo Bononi and Guercino, up to the sketches of the Gandolfi and Crespi.

Remarkable is the collection of paintings of the XV century, from the masters of the late Gothic to Cosmè Tura, Ercole de' Roberti and the other architects of the Ferrara workshop, flanked by foreign artists such as Gentile da Fabriano, Mantegna and Carpaccio. Part of the collections since the establishment of the Pinacoteca in 1836 is the series of altarpieces of the XVI century from the city churches, including numerous works by Garofalo, one of Raphael best followers in Northern Italy, the Costabili Polyptych by the latter in collaboration with the Giorgionesque Dosso Dossi and the dramatic paintings by Bastianino, with which the Este era in Ferrara ends.

- *City of Sassuolo*: it is the city in which it is possible to visit what is called the "Este delight": the Sassuolo Ducal Palace. In line with the baroque taste of the time, the Este family decided to build their holiday palace on the model of the main European palaces which, starting from the XVII

century, became the symbol of the era of Absolutism by virtue of its size and magnificence, the richness of the works of art specially created and the large spaces intended for park and hunting reserve that surround these buildings. The site, at the foot of the first Emilian hills and near the Secchia river, was chosen not only for the presence of an ancient castle on which the building rises, but also for the healthiness of its climate and its waters.

The history of the Palace dates back to time, probably to the time of Matilda of Tuscany. During the XIII century, it was registered as part of the Della Rosa reign until the Este conquest of 1373. It was the same Marquis (and later Duke) of Ferrara, Borso d'Este, who started the conversion of the Palace from a fortified manor, in a court residence which included the frescoes by Agnolo and Bartolomeo degli Erri. Throughout the XVI century the building remained in the possession of the Pio di Carpi family with works carried out by artists such as Nicolò dell'Abate (in the lost Orlando Apartment) and Domenico Carnevali (whose frescoes in the Chamber of the Chancellery survive only in fragments). Eventually, the castle returned to the Este family again and became a strategic seat for Francesco I d'Este new approach to politics. After the Casa d'Este moved its capital from Ferrara to Modena, Francesco I converted the Sassuolo residence into a Baroque palace, simultaneously transforming the Este castle of Modena into the colossal urban Ducal Palace. Under the team of artists gathered by the Duke, the environment of the Palace was transformed and reoriented towards natural light and the foothills: the corner towers were transformed into panoramic terraces, the courtyard became a theatrical space populated by a gigantic river god designed by Gian Lorenzo Bernini and Antonio Raggi and a portico with three staggered arches gave the illusion of symmetry on the new Baroque facade of the building, opening it towards the city. Bartolomeo Avanzini and Gaspare Vigarani designed bizarre creations such as the fishpond (the "Fontanazzo" adjacent to the square) while sculptors and plasterers like Lattanzio Maschio, Luca Colombi and Giovanni Lazzoni worked to produce sculptures for the atrium, Salone d'Onore and Stuccato Apartment.

In the Table below, it is possible to read some of the main data from the Gallerie Estensi Balance Sheet. Each museum is obliged to make these available and Table 5, together with the following tables related to the other two collaborating institutions, contains a synthesis and adaption of the Italian documents disclosed, with an analysis horizon of four years. For sake of simplicity, Current and Non-current Liabilities have been grouped into a single entry.

	2016	2017	2018	2019
Consolidated Balance Sheet: Assets				
Non-current Assets:	289,624.55	0.00	0.00	0.00
Current Assets:				
Inventories	0.00	0.00	0.00	0.00
Accounts receivable	0.00	235,368.94	4,127,773.66	3,695,241.77
Cash and cash equiv.	3,922,673.87	5,568,187.47	4,005,724.36	4,669,616.68
Total Assets:	4,212,298.42	5,803,556.41	8,133,498.02	8,364,858.45
Consolidated Balance Sheet: Equity & Liabilities				
Equity:	4,120,903.59	4,859,210.06	6,691,582.29	7,521,502.31
Liabilities:				
Accounts payable	0.30	944,346.35	1,441,915.73	843,356.14
Financial debt	91,394.53	0.00	0.00	0.00
Total Equity & Liabilities:	4,212,298.42	5,803,556.41	8,133,498.02	8,364,858.45
Consolidated statement of income				
Revenues	4,894,997.22	3,660,742.53	6,218,472.19	3,439,028.41
Operating costs	772,720.27	2,920,497.21	4,387,367.67	2,531,808.26
EBIT:	4,122,276.95	740,245.32	1,831,104.52	907,220.15
Financial income	0.24	0.29	3,638.07	(77,300.13)
EBT:	4,122,277.19	740,245.61	1,834,742.59	829,920.02
Taxes	1,373.60	1,939.14	2,370.36	0.00
Net profit (loss)	4,120,903.59	738,306.47	1,832,372.23	829,920.02

Table 5: Gallerie Estensi Financial Statement summary (€)

2.2.2 The Musei Reali of Turin

The Musei Reali of Turin are one of the largest and most varied museum complexes in Europe and are equal, for their size and the value of the collections, to the major European royal residences. They are located in the heart of the ancient city of Turin and offer an itinerary that winds through over 3 km of museum walk on 30,000 square meters of exhibition and storage spaces, 7 hectares of gardens, with testimonies dating from prehistoric times to modern age. Their origin dates back to 1563, when

Emanuele Filiberto di Savoia moved the capital of its Dukedom from Chambéry to Turin and began the great urban transformation and the enrichment of the dynastic collections.

As for the Gallerie Estensi, it is possible to quote their mission, which states: *“The mission of the Royal Museums is to preserve and enhance the heritage of monuments, works and spaces that originated from the dynastic history of the Savoia family and which qualifies an urban compendium located in the heart of the ancient city, placing it in a dynamic relationship with the visitor experience and developing opportunities for better access, knowledge, creativity and enjoyment. [...] the Musei Reali intend to offer their audiences a dynamic, innovative and welcoming service, aimed at cultural growth in the field of history and the visual arts.”*

Between the XVII and XVIII centuries the residence, with the Royal Palace in the centre, expanded in the shape of a city following the orthogonal scheme of the first urban expansion towards the Po river. Inhabited by the Savoy until 1946, it is now owned by the Italian state.

Since 2014, the Musei Reali have brought together in a single compendium six institutions previously separated by management and control: the Royal Palace, the Royal Armory, the Royal Library, the Savoia Gallery, the Museum of Antiquities, the Royal Gardens. As done for the Gallerie Estensi, a brief in-depth analysis is presented here for each of these main sites:

- *The Royal Palace:* in 1563, when Turin became the capital of the Dukedom, Emanuele Filiberto di Savoia established his residence in the bishop palace, but already in 1584 Carlo Emanuele I entrusted Ascanio Vitozzi with the construction of a new factory. After 1643, the direction of the works passed to Amedeo di Castellamonte and then to Carlo Morello. Meanwhile, the rooms on the first floor were furnished, with carved and gilded ceilings and large allegorical paintings by Jan Miel and Charles Dauphin, whose subjects exalt the virtues of the sovereign according to the program of the court rhetorician Emanuele Tesauo.

In 1688, Daniel Seyter was called from Rome to fresco the gallery since then known as “del Daniel”. Seyter, flanked by the Genoese Bartolomeo Guidobono, also intervened in the apartment on the ground floor, later known as Madama Felicita Apartment. At the end of the XVII century, the layout of the garden was revised and enlarged by the famous French architect André Le Notre. When Vittorio Amedeo II obtained the royal title, in 1713, the so-called “command area” was created, annexed to the palace and made up of Secretariats, Offices, Teatro Regio and State Archives. The director of these interventions was Filippo Juvarra, who also created the Scala delle Forbici and the Chinese Cabinet. The position of first royal architect then passed to Benedetto Alfieri, who defined the decorative apparatus of the apartments on the second floor and set up the new rooms of the Archives, frescoed by Francesco De Mura and Gregorio Guglielmi.

At the time of Carlo Alberto di Savoia (1831-1849) some rooms on the noble floor were renovated under the direction of Pelagio Palagi, such as the Salone degli Svizzeri and the Sala del Consiglio, and other rooms on the second floor, while in 1862 the new grand staircase was built. With the transfer of the capital from Turin to Florence and then to Rome, the palace gradually lost its functions of residence.

- *The Royal Armory*: the idea of establishing a museum dedicated to weapons dates back to the end of 1832 when Carlo Alberto di Savoia, after the foundation of the “Regia Pinacoteca”, began to collect in the Beaumont Gallery, now emptied of the large canvases that adorned the walls, the weapons owned by the Savoy family.

The organization was entrusted to Vittorio Seyssel D’Aix, captain of artillery and first director of the “Ancient and Modern Armory” which will be inaugurated in 1837. The objects initially come from the Arsenals of Turin and Genoa and from the collections of the Museum of Antiquities. To these were added exemplary purchases made in the antiques market, including the important collection of the Milanese scenographer Alessandro Sanquirico (1833) and the conspicuous collection belonging to the Martinengo della Fabbrica family from Brescia (1839). In 1840, the Museum was equipped with its first catalogue which described 1,554 objects and contained a series of lithographic reproductions useful to facilitate study and promotion.

In 1842, the premises of the Rotonda were added to the Beaumont Gallery, designed by Pelagio Palagi in order to house the most recent collections of the Carloalbertinian museum, including the collection of oriental weapons. This sector was further enriched, after 1878, with the donation of the personal collections of Carlo Alberto and Vittorio Emanuele II. With the advent of the Republic in 1946, the Armory, until then employed by the Ministry of the Royal House, became a state museum.

After a series of rearrangement and restoration works completed in 2005, the historicizing structure of the collection was redefined based on scenographic criteria. The Armory currently has more than 5,000 objects ranging from prehistoric times to the early XX century, among which one of the most important part is made up of XVI century weapons and armor. The Royal Medal Collection is also attached to the Armory, intended to host the collection of coins and a selection of classic antiques and precious objects by Carlo Alberto di Savoia in the precious Palagian furniture.

- *Royal Library*: the Royal Library of Turin is one of the most important cultural institutions in the city and contains over 200,000 volumes, ancient maps, engravings and drawings, such as the famous “Self-portrait” by Leonardo da Vinci.

In 1831 Carlo Alberto di Savoia decided to expand the court library with the inclusion of countless volumes purchased from antique dealers throughout Europe and his personal collection. For the development project of the Library, the king hired a small circle of collaborators which undertook numerous research trips abroad to update themselves on the progress of literature, science and arts. During these journeys, documents on the history of the dominions of the House of Savoy were collected, together with some other works notable for their rarity or beauty: as a result, the Library was enriched with precious volumes, ancient books and illuminated manuscripts.

In 1839 Carlo Alberto di Savoia bought from the collector Giovanni Volpato a series of drawings from the XV to the XVIII centuries by great Italian and foreign masters, including Michelangelo, Raphael, Rembrandt and Leonardo da Vinci. As regards the latter, in particular, the Library hosts 13 autographed sheets and the Code on the flight of birds, which however reaches the Library by donation in 1893.

With the rapid growth of book collections, the ancient site on the first floor of the Royal Palace soon proved insufficient. The project for the new headquarters was entrusted to the court architect Pelagio Palagi, who also designed the furnishings and shelves against the walls, arranged on two levels. In 1842 the new seat of the palatine library was inaugurated on the ground floor of the eastern wing of the Royal Palace.

Originally, the Royal Library was intended for the service of the court, for officers and scholars interested in the study of homeland history and fine arts. After the Second World War, with the passage to the State of the assets of the House of Savoy, the Royal Library became a state public library and, since 2016, it has been an institute attached to the Royal Museums of Turin.

- *Savoy Gallery*: it was established in 1832 by the will of Carlo Alberto. Initially welcoming the collections from the Royal Palace of Turin, the Savoy private collection and the Durazzo palace in Genoa (acquired in 1824), it progressively expanded with purchases and donations along the course of the XIX century to integrate or fill the gaps present in the Savoia collections, especially as regards the Italian Renaissance.

The Royal Gallery was initially set up on the noble floor of Palazzo Madama; in 1860 it was ceded to the state by Vittorio Emanuele II and in 1865 the museum was moved to the second floor of the Academy of Sciences building. In 1930, the Pinacoteca was further enriched by the donation of the ancient art collection of the Piedmontese industrialist Riccardo Gualino including paintings, sculptures, precious objects, furniture and archaeological finds from different eras and cultures, which was set up as a house-museum.

In December 2014, the Museum changed its location and the collections were rearranged in the so-called Manica Nuova of the Royal Palace, built between the end of the XIX century and the

beginning of the XX century by the court architect Emilio Stramucci. About 500 works by Piedmontese, Italian, Dutch, Flemish and European artists are currently exhibited on four levels of visit in a chronological period ranging from the XIV to the XX centuries. Among these, it is possible to admire paintings by Beato Angelico, Pollaiuolo, Filippino Lippi, Mantegna and Paolo Veronese. Works by Piedmontese painters such as Martino Spanzotti, Defendente Ferrari, Macrino d'Alba and Gaudenzio Ferrari are on display as well.

Among the Italian paintings of the XVII and XVIII centuries, are also included Lombard and Caravaggesque works, such as the Annunciation by Orazio Gentileschi, masterpieces by Guido Reni, Guercino, Sebastiano Ricci, Francesco Solimena, Giuseppe Maria Crespi and the famous views of Turin made by Bernardo Bellotto.

The Savoy Gallery also boasts a rich presence of Flemish and Dutch school paintings from the XV to the XVII centuries, among which there are tables by Jan van Eyck, Rogier van der Weyden, Hans Memling. Extraordinary in importance and pictorial quality are Rembrandt van Rijn Portrait of an Old Man, the two canvases depicting Hercules and Dejanira by Pieter Paul Rubens, the sons of Charles I of England and Prince Thomas of Savoy-Carignano on horseback, realized by Anton van Dyck. Works by Gerard Dou, Paulus Potter and David Teniers come from the picture gallery of Prince Eugene of Savoy Soissons (1663-1736), a commander in the service of the Viennese court and cultured collector.

- *Museum of Antiques*: it is composed of different sections: the Manica Nuova, with the Archeology exhibition in Turin and the Marengo Treasure Rooms; the Territory, dedicated to the archeology of Piedmont and the “Exhibitions on the catwalk”; the Collections, the “historical” nucleus of the Museum and home to the preparation of the Papyrus of Artemidorus.

The underground floor of the Manica Nuova of Palazzo Reale has been hosting, since 2013, the renovated setting up of the Marengo Treasury and the Archeology exhibition in Turin which presents the archaeological materials of the city, coming from the collections of the XVI century scholars, increased by the antiquaries of the following centuries and merged into the royal collections, together with the new acquisitions resulting from recent archaeological excavations. The section connects with the archaeological area of the Roman theatre, which it partially contains and overlooks.

The section of the Territory has been set up, since 1998, in a new architectural structure, partly underground, which exhibits the archaeological materials found in Piedmont in the past and in the most recent excavations. Small temporary exhibitions alternate on the connecting walkway between the Manica Nuova and the Collections pavilion.

The Historical Collections represent the original nucleus of the Museum formed when Duke Emanuele Filiberto di Savoia (1553-1580) began the collection of antiquities, increased by his successors and rearranged by Vittorio Amedeo II, king of Sardinia, who donated these to the University of Turin. The archaeological collections found, in 1989, an accommodation in the Orangeries of the Royal Palace, home of the Artemidorus Papyrus Preparation since 2014.

- *The Royal Gardens*: they constitute a unique urban green area in terms of monumental and environmental value. They develop in the portion still enclosed by the ramparts, on a total area of about seven hectares. The first plant dates back to the time of Emanuele Filiberto di Savoia (1528-1580) and subsequently important changes took place at the end of the XVII century and in 1886. The route includes the Ducal Garden, north of the Royal Palace, the Garden of Arts to the east, resulting from the enlargement wanted by Carlo Emanuele II (1634-1675) and the Boschetto, in the north-east sector, originated in XIX century. The stone furniture has its centerpiece in the fountain of the Tritons by Simone Martinez (1756), with large vases, statues and benches built by Ignazio and Filippo Collino.

In 1997, following the tragic fire that hit the Shroud Chapel, the Royal Gardens were closed to the public. In 2008, restoration work began, financed by the European Regional Development Fund, which led to the partial reopening in 2016, while restoration works were completed in 2018. They are divided in five main areas: the Garden of the Duke; the Grove; the Garden of Arts; the Walls and the “Garittone”; the Lower Gardens.

In addition to these, it is also necessary to include two further sites which are under the responsibility of the Musei Reali These are respectively:

- *The Chapel of the Holy Shroud*: the historical and architectural events that led to the construction of the Chapel of the Holy Shroud in its current configuration are very long and troubled, covering a time span of about eighty years (1611-1694).

The Chapel of the Holy Shroud was originally commissioned by the Duke Carlo Emanuele di Savoia to Carlo di Castellamonte (1611) to preserve the precious relic, kept by the Savoy ducal family since 1453 and transported to Turin in 1578.

Over time, however, the projects were first modified by Amedeo di Castellamonte, son of Carlo di Castellamonte, and, after him, by the Swiss Bernardino Quadri (1657), who was responsible for the design of a square-based building set between the ducal palace (former episcopal palace and future Royal Palace) and the apse of the Cathedral of San Giovanni Battista.

In 1667, the project was ultimately entrusted to the Theatine friar and great architect of the Baroque Guarino Guarini, who revolutionized and completed (until 1683, the year of his death)

the project of Bernardino Quadri, creating the internal circular plan raised by a level with respect to the presbytery of the Cathedral, thus placing it directly in communication with the courtly rooms on the first floor of the Royal Palace.

The construction site was definitively closed in 1694, when the relic of the Holy Shroud was moved to the Guarini Chapel to be placed in the central altar designed by Antonio Bertola.

In the first half of the XIX century, the Chapel of the Holy Shroud was finally adorned with four sculptural groups commissioned by King Charles Albert, representing the great figures of the House of Savoia (Thomas I, Amedeo VIII, Emanuele Filiberto and Carlo Emanuele II di Savoia).

From 1694 until the early nineties of the XX century, the Chapel of the Holy Shroud kept the precious relic, now preserved in the transept of the Turin Cathedral.

In the night between 11 and 12 April 1997, the Chapel of the Holy Shroud was affected by a fire of vast proportions that damaged the building. As a consequence, a long and demanding structural restoration intervention was necessary, aimed at re-establish its bearing capacity and its image. After the long restoration, the admirable Baroque architecture of Guarino Guarini was finally returned to the world, accessible to the public during the visit of the Musei Reali, with the opening ceremony that took place on 27 September 2018.

- *The Chiabrese Palace*: it represents one of the noble palaces in the historic centre of Turin, whose events are linked to the history of the Royal House of Savoia.

Belonging to the buildings that make up the command area, it is connected to the Royal Palace by an internal passage and has the main entrance and the historic view of Piazza San Giovanni.

With a XVII century layout, the Palace was redesigned in 1753 by the architect Benedetto Alfieri on behalf of the King to be used as the residence of Benedetto Maria Maurizio, Duke of Chiabrese, from which it takes its name. The majestic staircase leading to the main floor dates back to this period, where there are sumptuous decorations, stuccos, furnishings, painted over doors and boiserie.

The Palace, used over the centuries as the residence of the Savoia family, was damaged during the Second World War and later passed to the Italian State which restored and used it as the seat of the Regional Directorate for Cultural and Landscape Heritage of Piedmont and the Superintendencies. The rooms on the ground floor of Chiabrese Palace, historically intended for service areas and almost devoid of decorations, host temporary exhibitions of the Musei Reali complex. These exhibitions are often dedicated to international artists and allow visitors to take a journey through history and art, from the Roman era to the XXI century.

With the same approach used in the previous Section, Table 6 reports a quick overview of the financial results of the Musei Reali of Turin, for four years starting from 2016.

	2016	2017	2018	2019
Consolidated Balance Sheet: Assets				
Non-current Assets:	507,531.38	0.00	0.00	0.00
Current Assets:				
Inventories	0.00	0.00	0.00	0.00
Accounts receivable	129,051.47	1,537,295.66	1,779,688.24	5,427,616.96
Cash and cash equiv.	6,261,199.37	6,706,952.82	5,299,200.42	4,335,574.21
Total Assets:	6,897,782.22	8,244,248.48	7,078,888.66	9,763,191.17
Consolidated Balance Sheet: Equity & Liabilities				
Equity:	5,374,663.90	4,252,090.53	3,611,752.72	5,022,888.40
Liabilities:				
Accounts payable	1,523,118.32	3,992,157.95	3,467,135.94	4,740,302.77
Financial debt	0.00	0.00	0.00	0.00
Total Equity & Liabilities:	6,897,782.22	8,244,248.48	7,078,888.66	8,364,858.45
Consolidated statement of income				
Revenues	9,195,967.53	8,939,886.54	6,693,199.18	9,635,341.17
Operating costs	3,821,303.63	8,278,029.05	7,655,661.62	8,305,154.65
EBIT:	5,374,663.90	661,857.49	(692,462.44)	1,330,186.52
Financial income	0.00	(1,705,409.84)	129,605.77	152,535.16
EBT:	5,374,663.90	(1,043,552.35)	(562,856.67)	1,482,721.68
Taxes	0.00	79,021.02	77,481.14	71,586.00
Net profit (loss)	5,374,663.90	(1,122,573.37)	(640,337.81)	1,411,135.68

Table 6: Musei Reali Financial Statement summary (€)

2.2.3 The Palazzo Ducale of Mantua

Initially made up of disaggregated buildings, the Palazzo Ducale found an organic shape in the first half of the XVI century, when it became a single, grandiose architectural complex corresponding to the oldest city district. The Gonzaga family made it their residence from 1328 to 1707, when the last duke Ferdinando Carlo, accused of felony, was forced into exile. On April 2, 1707, the House of Austria claimed direct dominion of the Mantuan Dukedom and begun the Habsburg governorship.

The oldest buildings are the Palazzo del Capitano and the Magna Domus, erected by the Bonacolsi family who dominated Mantua from 1273 to 1328. With the taking of power by the Gonzaga, new factories joined the original nucleus and the so-called Corte Vecchia is formed.

Between 1395 and 1406, on a project by Bartolino da Novara, the Castle of San Giorgio was built. This, starting from the mid XV century at the behest of Ludovico II Gonzaga, became the residence of the marquis family. In the north-east tower, Andrea Mantegna frescoed the famous Camera degli Sposi, in the period between 1465 and 1474. On the main floor there are also the first Studiolo and the first Grotto of Isabella d'Este, wife of Francesco II Gonzaga.

The Domus Nova, modified by Duke Vincenzo I Gonzaga (1587-1612), rises against the Corte Vecchia starting from 1480. Not far from the Castle of San Giorgio, Giulio Romano built the so-called Corte Nuova, whose first nucleus is the Troia Apartment (1536-1539). He was also responsible for the conception of the Rustica, then connected to the Corte Nuova by the Galleria della Mostra e dei Mesi. After the middle of the XVI century, the work of Giovan Battista Bertani took shape, the Cortile della Mostra, which in the XVIII century took the name of Cavallerizza.

Due to the death of Francesco II Gonzaga (1519), Isabella d'Este moved from the Castle to Corte Vecchia. The widow apartment includes some magnificent rooms frescoed by Lorenzo Leonbruno, among these the Camera Granda, the Studiolo, the Grotto and the Secret Garden. In the eighties of the XVI century, Duke Guglielmo Gonzaga (1550-1587), grandson of Isabella d'Este, commissioned Bernardino Facciotto to transform the rooms of Corte Vecchia, in which there was the Refettorio, overlooking the Hanging Garden, and the Sala dello Specchio, intended for music, facing the Courtyard of the Eight Faces. On the ravelin of San Nicolò, Guglielmo had the large apartment of Castello built with the rooms dedicated to the Captains, the Marquises and the Gonzaga Dukes, which can be accessed from the majestic Sala di Manto. From 1563, Giovanni Battista Bertani built the palatine church of Santa Barbara, which can be considered the visual pivot of the building, connected both to the Appartamento Grande of the Castello and the corridor of Santa Barbara.

In the early XVII century, Duke Vincenzo I Gonzaga (1587-1612) commissioned the Cremonese architect Antonio Maria Viani to transform a wing of the Domus Nova, chosen as his own residence, with access from the atrium of the Archers. The gallery on the Cortile d'Onore, used as a shelter for the ducal collection of paintings, was soon closed and transformed into a Gallery (from the late XVIII century, called the "Gallery of Mirrors"). In Viani, the fourth Duke of Mantua also commissioned the Metamorphosis Gallery, where the natural and artificial wonders are located. The rooms, dedicated to the four elements, overlook the garden formerly of the Pavilion, designed by the botanical friar Zenobio Bocchi for Vincenzo I Gonzaga in 1603.

In the Domus Nova, Ferdinando Gonzaga (1613-1626) had the Paradise Apartment built. This currently represents the headquarters of the Museum, containing the Scala Santa (1615). This consists in a miniature reproduction of the one kept in San Giovanni in Laterano in Rome, a celebrated setting by Giovanni Rodari as the Apartment of the Court Dwarves: a false historical, made credible for a long time by the proportions of the rooms. Between 1627 and 1628, to cope with the economic difficulties of the Dukedom, the finest pieces of the Gonzaga collections were sold by Vincenzo II Gonzaga to the King of England Charles I Stuart. In 1630, what remained of the works of art and artistic artefacts preserved in the Palazzo Ducale was sacked by the Lanzichenecchi, brought back by Emperor Ferdinand II to punish Charles I Gonzaga Nevers, guilty of a pro-French policy.

During the domination of the Gonzaga-Nevers, some decorative elements were created, in particular in the Corte Vecchia. Architectural interventions resumed in the mid XVIII century, during the first decades of the Habsburg domination. From the seventies of the XVIII century the Palace, intended as a residence and seat of the government, was restored and renovated: the Sala dei Fiumi is of late Baroque character, the Tapestry Apartment and the Empress Apartment were built in neoclassical style instead. Following the annexation of Mantua to the Kingdom of Italy (1866), the Palace became the subject of important restoration campaigns between the last years of the XIX century and the first four decades of the XX century. These interventions have strongly conditioned the current appearance of the palatine complex. As an example, Gothic robes were given to the Castle of San Giorgio and to the facade of the Palazzo del Capitano.

Among the numerous works now exhibited in the halls of Palazzo Ducale stand out authentic masterpieces, such as the altarpiece depicting "The Gonzaga Family in adoration of the Trinity" (1605) by Pieter Paul Rubens and the "Multiplication of the loaves and fishes" (1619) by Domenico Fetti, coming respectively from the Mantuan churches of Santissima Trinità and Sant'Orsola. Only a small part of the works contained in the Palazzo Ducale can be considered as originally belonging to the immense artistic heritage of the Gonzaga age, almost all dispersed following the sale of 1628 and the sack of Mantua in 1630. Among the few surviving works, there are the painting by Domenico Morone depicting "The expulsion of the Bonacolsi" (1494) and the cycle of nine Raphaelesque tapestries with stories taken from the Acts of Apostles, who decorated the palatine basilica of Santa Barbara, realized in Brussels and purchased by Cardinal Ercole Gonzaga in 1559. As regards the impressive collection of the ancient statues, remains the series of 64 imperial busts executed between the I century B.C. and the III D.C. Of remarkable level are some fronts of sarcophagi of the II and III century D.C. In particular, those including the labours of Hercules, the sack of Troy, the struggle between Greeks and Amazons, the myth of Adonis. A considerable part of the furnishings and furniture on display date back to the second half of the XVIII century or the early XIX century,

therefore to the periods of the Habsburg and Napoleonic empires, when the Palazzo Ducale complex became the seat of the respective governors and officials.

Concluding, as done for the previous two institutions, Table 7 below provides the main accounting data available. Unfortunately, at the moment of writing of this Master Thesis, data about 2018 and 2019 were still not disclosed and only the two years 2016 and 2017 are here showed. However, this can be considered sufficient in order to gather an idea of the financial structure and the economic value generated by Palazzo Ducale.

	2016	2017	2018	2019
Consolidated Balance Sheet: Assets				
Non-current Assets:	0.00	0.00	n.a.	n.a.
Current Assets:				
Inventories	0.00	0.00	n.a.	n.a.
Accounts receivable	2,140,818.10	2,026,872.40	n.a.	n.a.
Cash and cash equiv.	2,316,796.69	3,504,132.86	n.a.	n.a.
Total Assets:	4,457,614.79	5,531,005.26	n.a.	n.a.
Consolidated Balance Sheet: Equity & Liabilities				
Equity:	3,865,645.40	4,247,264.30	n.a.	n.a.
Liabilities:				
Accounts payable	591,969.39	1,283,740.96	n.a.	n.a.
Financial debt	0.00	0.00	n.a.	n.a.
Total Equity & Liabilities:	4,457,614.79	5,531,005.26	n.a.	n.a.
Consolidated statement of income				
Revenues	5,875,773.60	3,407,502.59	n.a.	n.a.
Operating costs	2,007,667.84	3,015,940.82	n.a.	n.a.
EBIT:	3,868,105.76	391,561.77	n.a.	n.a.
Financial income	0.00	70.96	n.a.	n.a.
EBT:	3,868,105.76	391,632.73	n.a.	n.a.
Taxes	2,460.36	10,013.83	n.a.	n.a.
Net profit (loss)	3,865,645.40	381,618.90	n.a.	n.a.

Table 7: Palazzo Ducale Financial Statement summary (€)

2.3 The COVID-19 pandemic

The previous Paragraph was aimed to emphasize and became familiar with the concept of Museum, something that is clearly picturable by everyone but that, at the same time, hides various meanings and possess ancient roots. Moving forward, this Paragraph tackles the current COVID-19 disease, with a twofold objective. The first two Sections deal directly with the outbreak of the pandemic, with a particular focus toward the Italian situation, retracing the spread of the contagions started at the beginning of 2020, together with the main measures undertaken by the Italian government in order to contain the virus. The last one, instead, is dedicated to the finding of tools already existing in literature which can be used in order to better model the scenario (and its evolution) from an economic point of view.

2.3.1 The COVID-19 disease

COVID-19, acronym of Corona Virus Disease 19, also known as acute respiratory disease from SARS-CoV-2² or Coronavirus disease 2019, is an infectious respiratory disease caused by the virus named SARS -CoV-2 belonging to the Coronavirus family. The incubation period on average is 15 days and, for this reason, an isolation period of 14 days has been indicated in a situation of possible exposure to a suspected or confirmed case. During the incubation period the infected person is contagious, subsequently symptoms might appear. The virus is transmitted by air, most often via respiratory droplets. To limit their transmission, precautions must be taken, such as maintaining a safety distance of at least 1.5 meters, and maintaining correct hygiene behaviours (periodically washing hands, sneezing or coughing into a tissue or with the elbow flexed and, where necessary, wear masks and gloves).

The virus primarily affects the lower respiratory tract and causes a range of flu-like symptoms, including fever, cough, shortness of breath, muscle pain, fatigue and gastrointestinal disturbances. In severe cases, pneumonia, acute respiratory distress syndrome, sepsis, septic shock and a cytokine storm may occur, even leading to the death of the patient. The treatment currently consists in the isolation of the patient and managing its clinical symptoms.

Around the middle of December 2019, health authorities in the city of Wuhan in China (approximately 11 million inhabitants) found the first cases of patients showing symptoms of a pneumonia due to unknown cause. This first group of sick people was somehow connected to the local wet market, consisting of about a thousand stalls on which wild animals of various kinds were

² Severe Acute Respiratory Syndrome Coronavirus 2

sold. The origin is still uncertain today, but the most accredited hypothesis is that it is a new Coronavirus coming from an animal source. The strain responsible for the pandemic was identified in early January 2020 and designated SARS-CoV-2 or "New Coronavirus of Wuhan", while its genome was published on January 10.

Several measures are commonly used to quantify mortality. These numbers vary by region and over time and are influenced by the volume of testing, healthcare system quality, treatment options, time since the initial outbreak, and population characteristics such as age, sex, and overall health (H. Ritchie & M. Roser, 2020). The death-to-case ratio reflects the number of deaths divided by the number of diagnosed cases within a given time interval. Based on Johns Hopkins University statistics, the global death-to-case ratio is 2.8% as of 16 October 2020 and the number varies by region (M. Lazzarini & G. Putoto, 2020). Other measures include the CFR³, which reflects the percentage of diagnosed individuals who die from a disease, and the IFR⁴, which reflects the percentage of infected individuals (diagnosed and undiagnosed) who die from a disease. These statistics are not time-bound and follow a specific population from infection through case resolution. Many academics have attempted to calculate these numbers for specific populations. In February, the World Health Organization reported estimates of IFR between 0.3% and 1%. On July 2, 2020, The WHO Chief Scientist reported that the average IFR estimated was about 0.6%.

The Centre for Disease Control and Prevention of the United States of America estimated, for planning purposes, that the IFR was 0.65% and that 40% of infected individuals were asymptomatic, suggesting a fatality rate among those who are symptomatic of 1.1% (as of July 10, 2020). Studies incorporating data from broad serology testing in Europe show IFR estimates converging at approximately 0.5–1%. According to the Centre for Evidence-Based Medicine of the Oxford University, random antibody testing in Germany suggested a national IFR of 0.4%.

Fixed lower limits of IFRs have been established in a number of locations such as New York City and Bergamo in Italy, since this indicator cannot be less than the population fatality rate. Wilson and Linus (2020) suggested that, as of July 2020, in New York City 23,377 individuals (18,758 confirmed and 4,619 probable) have died with COVID-19 (0.3% of the population). The antibody testing in New York City suggested an IFR of 0.9% while, in Bergamo province, 0.6% of the population has died (C. Modi, 2020).

Concluding with a general remark, the two Figures below shows the worldwide situation as of September 2020, both in terms of total confirmed cases (Figure 11) and total confirmed deaths (Figure 12).

³ Case Fatality Rate

⁴ Infection Fatality Rate

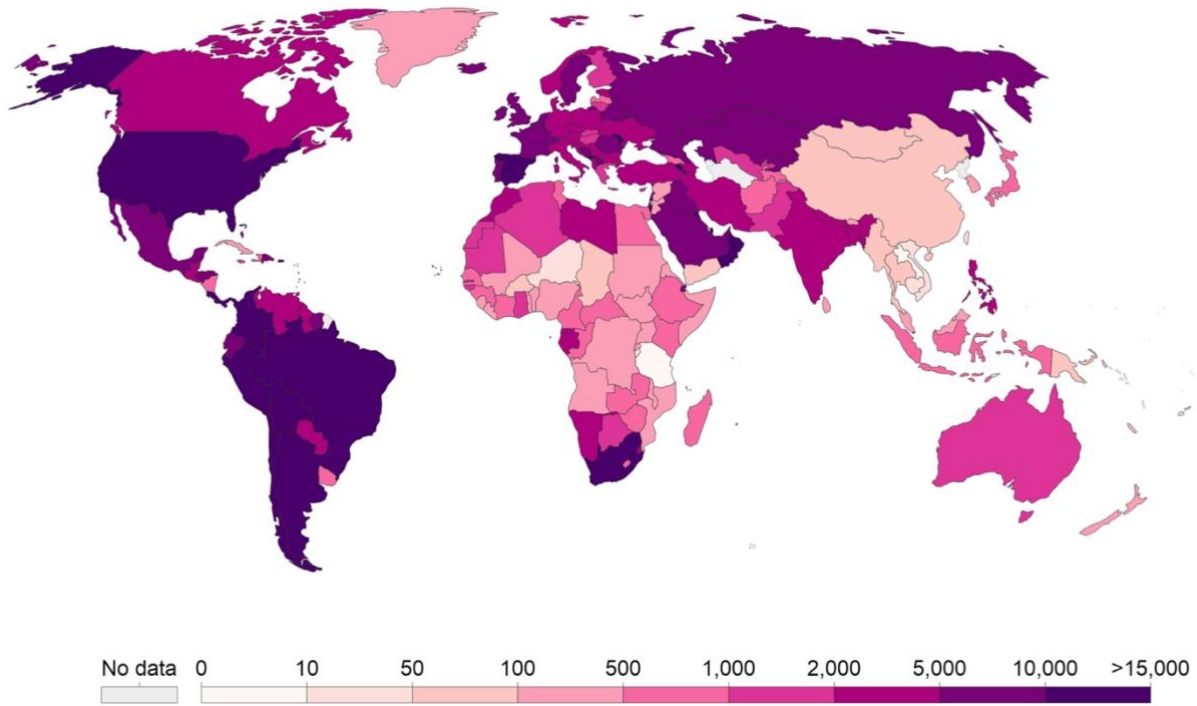


Figure 11: Total confirmed COVID-19 cases per million people as of Sep. 19, 2020 (European CDC)

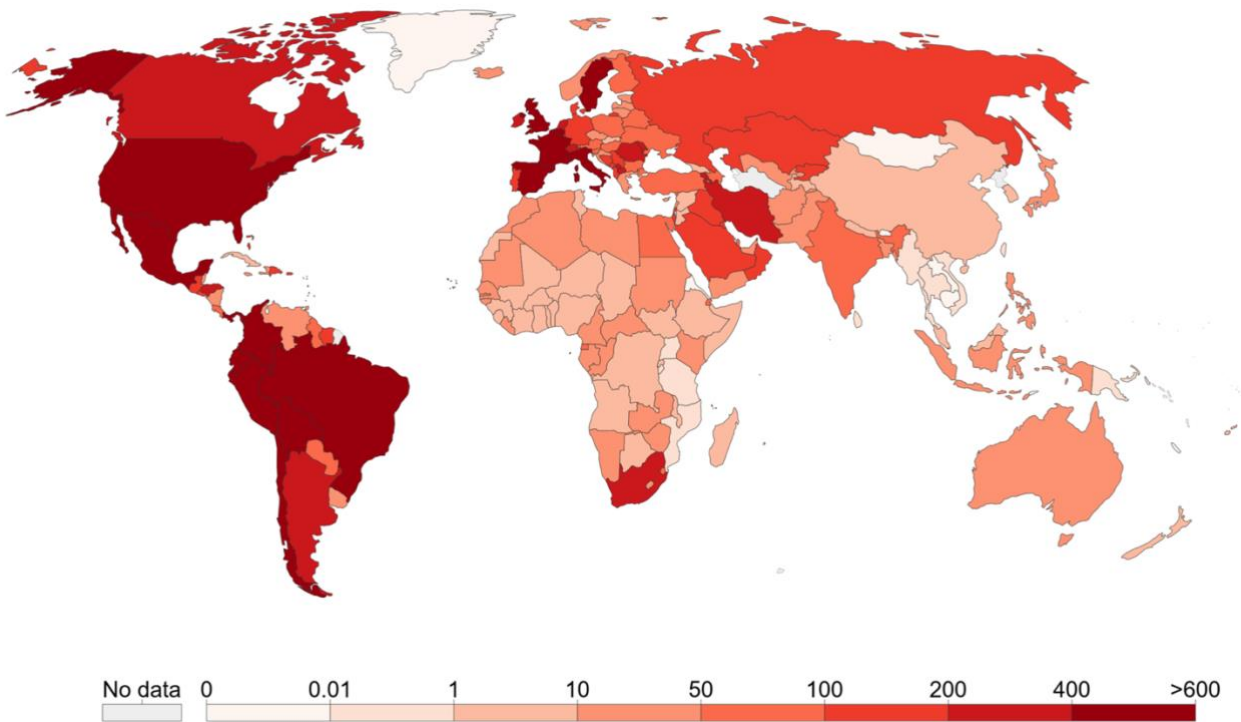


Figure 12: Total confirmed COVID-19 deaths per million people as of Sep. 7, 2020 (European CDC)

Models which try to predict events such as how a disease spreads also exist. The main parameters forecasted by these are, for example, the total number infected, the duration of an epidemic or others various epidemiological parameters, such as the reproductive number. For sake of simplicity, in this

Section it is reported the SIR⁵ model, the simplest among the category of the so-called compartmental models, which are aimed to simplify the mathematical modelling of infectious diseases by assigning population to compartments with labels (Figure 13). The SIR model is an instrument that divides the population with respect to the virus and regulates the passage between states (P. Girardi,2020).

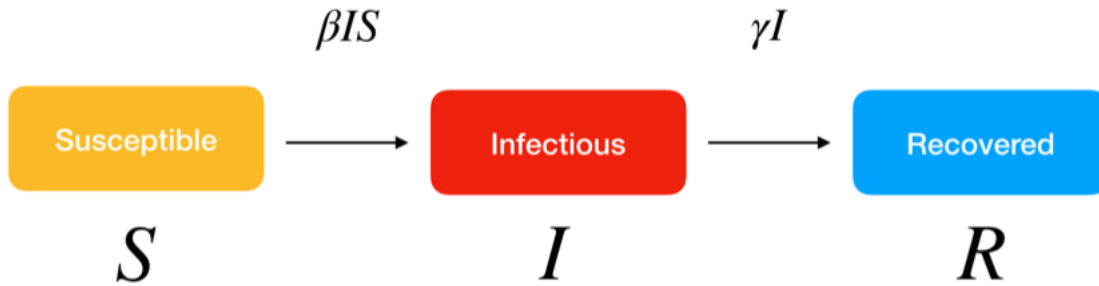


Figure 13: SIR model labels (P. Girardi, 2020)

The SIR model can be solved both with a stochastic (probabilistic) discrete-time approach and with a deterministic continuous-time model. In the deterministic SIR model, the transition between states is determined by this series of differential equations:

$$\left\{ \begin{array}{l} \frac{dS}{dt} = -\beta SI \\ \frac{dI}{dt} = \beta SI - \gamma I \\ \frac{dR}{dt} = \gamma I \end{array} \right.$$

An index, called R_0 , is connected to this model, which is the basic reproducibility index and controls the transmission of the disease and is calculated from the ratio:

$$R_0 = \frac{\beta}{\gamma}$$

This value indicates how many new infected an infected are generated, if $R_0 < 1$ the epidemic is in control. From the observed population and assuming an exponential growth, it is possible to forecast the number of infections, starting from the previous equation, as follows:

$$I(t) \approx I(t - 1)e^{(R_0 - 1)(\gamma)t}$$

Turning to logarithms it is possible to obtain:

$$\log I(t) \approx \log I(t - 1) + (R_0 - 1)(\gamma)t$$

⁵ Susceptible Infectious Recovered

Which can be seen as a linear regression model:

$$y(t) \approx \alpha + \beta_1 t$$

Where:

$$\alpha = \log I(t - 1) \text{ and } \beta_1 = (R_0 - 1)(\gamma)$$

Basically, an estimate of R_0 can be obtained from:

$$\widehat{R}_0 = 1 + \frac{\widehat{\beta}_1}{\gamma}$$

Where γ can be fixed, according to previous publications in 1/18 (H. Wang et al., 2020), while β_1 is estimated with linear regression methods.

Of course, the value of R_0 depends on many factors and not only on the infectivity of the pathogen. It is for this reason that lately, during the Coronavirus pandemic, many have preferred to use the expression R_t , which is the reproduction index at the time. Therefore, this index depends on the containment measures adopted and often, unlike R_0 , R_t is used precisely as a rate of reproduction, representing the number of subjects infected by an infected subject in the unit of time.

2.3.2 The evolution of the COVID-19 pandemic in Italy

The inclusion of this Section is due to the extraordinary nature of the situation to which this work is linked. For sake of correctness, it would not be fair to classify this part as traditional literature review. Indeed, rather than an accurate research about a specific topic, this Section is mainly dedicated to the description and recap of the sequence of facts happened starting from the diffusion of the COVID-19 pandemic in Italy. However, the presence of this Section is retained meaningful for two main reasons. First of all, even though this Master Thesis belongs to the Management Engineering field, in order to deal with such a complex topic and situation it has been fundamental gathering at least a generic perspective of the main consequences brought by the ongoing pandemic. Secondly, this Section can also be seen as the description of the context in which the working group operated while building the reported model. In these uncertain conditions, being aware of the environment and the directives adapted by the government, was as important as searching for scientific papers supporting the model. On January 12, 2020, the World Health Organization (WHO) confirmed that a novel Coronavirus was the cause of a new lung infection affecting several residents of the city of Wuhan, in the Chinese province of Hubei, whose case was brought to the attention of WHO on 31 December 2019. Although the death rate from COVID-19 has turned out to be lower than that of the SARS outbreak that raged

in 2003, the transmission of the SARS-CoV-2 virus, underlying COVID-19, is found to be much larger than that of the previous virus from 2003 and led to a much higher total death toll.

On January 30, 2020, the first two cases of COVID-19 in Italy were confirmed: in Rome, a couple of Chinese tourists aged 66 and 67 from the province of Hubei and landed on January 22 at Milan-Malpensa airport, who had visited the capital on a bus tour, tested positive for the SARS-CoV-2 virus; they were consequently hospitalized and then released. As a consequence, the Italian government suspended all flights to and from China and declared a state of emergency. Prime Minister Giuseppe Conte said Italy was the first EU country to take this precautionary measure.

On January 31, 2020, with a resolution of the Council of Ministers, a state of emergency on the national territory relating to the health risk, connected to the onset of pathologies deriving from transmissible viral agents, was declared for six months, after the Public Health Emergency of International Concern (PHEIC), launched by the World Health Organization, through its Director Tedros Adhanom Ghebreyesus. On February 17, 2020, a 38-year-old citizen of Castiglione d'Adda, in the Italian region of Lombardy, who had never been to China, presented himself at the Codogno civic hospital after symptoms of flu, identified as mild pneumonia. Returning for the second time to the emergency room, when his condition worsened, doctors decided to perform the diagnostic swab not yet foreseen by the health protocols. The patient, and later his pregnant wife and a friend, tested positive. This was just the first of many outbreaks that broke out in Italy between February and March 2020, especially in the northern regions. In order to face this, the Italian government implemented a series of particular laws and protocols which are hereby listed. Their weight and geographical coverage rapidly increased, due to the immediate worsening of the contagions between the end of February and the beginning of March 2020 (Figure 14).

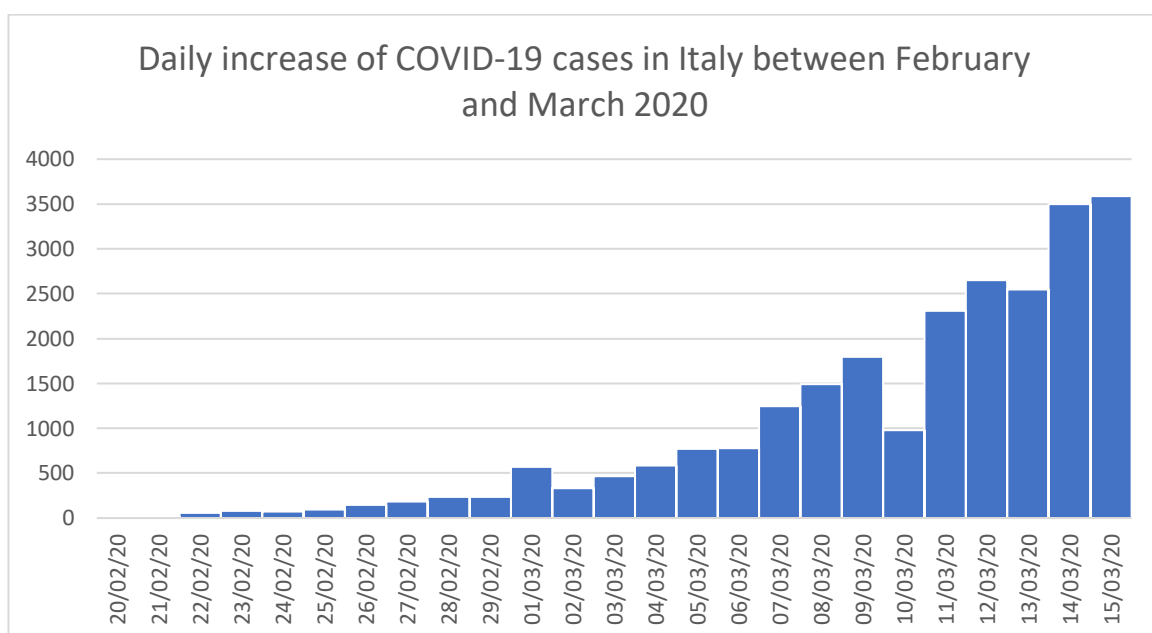


Figure 14: Daily increase of COVID-19 cases in Italy between February and March 2020 (Worldometer.info)

- *The first law decree:* on February 21, the Minister of Health issued an ordinance that provided for mandatory quarantine for those who had been in contact with people positive for viral infection, and active surveillance and home stay for those who had been in the areas at risk in the previous 14 days, with the obligation to report to local health authorities. On the same day, an ordinance signed jointly with the presidency of the Lombardy Region was added, which suspended all public events, commercial activities not of public utility, work, recreational and sports activities, also disposing the closure of schools in 10 municipalities where outbreaks initially happened. The ordinance did not have a predetermined duration, since the situation would have been monitored day by day and the decisions taken based on the evolution of the general context. The following day, the Council of Ministers announced a new decree-law to contain the pandemic, which provided for the quarantine of over 50,000 people from the 10 aforementioned Lombard municipalities, together with the town of Vo' Euganeo in Veneto. The Decree also entailed the suspension, in these areas, of events and initiatives of any nature, both public and private, the closure of schools of all levels, museums and other institutes and places of culture and all commercial activities (excluding those for the sale of basic necessities, which can be accessed only wearing personal protective equipment). At the same time, the armed forces were also sent to impose the blockade of the municipalities in quarantine.
- *The implementing decrees:* with a Decree of the President of the Council of Ministers of 25 February (an extension of a previously published Decree dating February 23, 2020), relating to the regions of Emilia-Romagna, Friuli-Venezia Giulia, Lombardy, Veneto, Piedmont and Liguria, the government measures were extended in addition to the 11 municipalities at the epicentre of the Coronavirus outbreaks, with provisions mainly relating to schools, museums, judicial offices, teleworking, valid until March 15. The suspension of all sporting events in the aforementioned regions was confirmed, allowing the holding of competitions and matches without an audience. The next day a Decree valid for the other regions was published, in order to stop the proliferation of different ordinances between one region and another, which described the preventive measures to be taken to prevent the spread of the disease, and measures for prophylaxis, together with the treatment of individuals who have stayed in areas of China or in municipalities with local transmission of the virus. On March 1, 2020, a new Decree of the Prime Minister acknowledged and extended some of the previous measures and introduced further ones, to ensure uniformity throughout the national territory. On March 4, 2020 with a further presidential Decree, the government announces measures valid throughout the national territory: the suspension of educational activities in all schools of all grades and universities until the following March 15,

the closure of the doors of all stadiums until April 3 and indications regarding the access of relatives and visitors to health facilities, and for prisons and penal institutions for minors. On the night between 7 and 8 March 2020, the Prime Minister issued a new Decree, which replaced the previous Prime Ministerial Decrees, with restrictive measures that apply to Lombardy and 14 provinces of the Centre-North of the country, for a total of 16 million people. This Decree prohibited any movement to and from the territories subject to restriction, as well as within the territories themselves.

- *March 9-May 3 (Phase 1/Lockdown)*: with the Prime Ministerial Decree of March 9, 2020, the provisions already imposed by the Decree of March 8 were extended to the whole national territory, starting from the following day, until April 3, 2020.

On March 11, the "*#IoRestoCasa Decree*" was published, which provided for the suspension of common retail commercial activities, educational activities, catering services and prohibited the gathering of people in public places.

In the late evening of March 21, 2020, live nationally at about 11.30 pm, the Prime Minister Giuseppe Conte announces the implementation of more stringent measures which reports the closure of all those activities not deemed necessary for the Italian production chain in relation to the contingent situation. On March 22, 2020, a new ordinance was jointly adopted by the Minister of Health and the Minister of the Interior which forbade all physical persons from moving or traveling by public or private means of transport in municipalities other than that in which they are located, except for proven work needs, absolute urgencies or health reasons. On the same day, President Giuseppe Conte also signed the new Prime Ministerial Decree, relating to the closure of all unnecessary activities, also publishing a list (subsequently expanded) of all those which, on the contrary, were considered necessary and strategic, with validity from March 23 to April 3.

Companies, whose activities were not suspended, must comply with the contents of the "*Shared Regulatory Protocol of Measures for the Fighting and Containment of the Spread of the COVID-19 Virus in the Workplace*", signed on March 14, 2020, between the Government and the social partners. The measures adopted were further extended until April 13 with a new DPCM⁶, and subsequently, after the conference of the Prime Minister on April 10, until May 3.

- *May 4-June 14 (Phase 2/ Easing of the containment measures)*: on the evening of April 26, 2020, Prime Minister Giuseppe Conte announced a new Prime Ministerial Decree effective from May 4, 2020, which provided for the start of the so-called "Phase 2", resulting in a gradual release of the previous containment measures, since the pandemic was in a descendent phase. In the first two weeks, the Decree also added the possibility of visiting relatives within the regional territory

⁶ Decreto del Presidente del Consiglio dei Ministri

(but always keeping the distance of at least one meter and with the mandatory use of masks and gloves), allowed the opening of public parks, the take-away service for catering activities, the resumption of various production activities with the wholesale trade, the reopening of bathing establishments and has also permitted the carrying out of physical activities regardless of the distance from home. Religious celebrations remained closed to the public, with the exception of funerals, with a maximum number of 15 participants allowed. The autonomous province of Bolzano, on May 8, 2020, was the first territory in Italy to grant the reopening of retail businesses and, from May 11, that of museums and activities such as bars, restaurants, hairdressers and beauty centres. These activities were resumed throughout Italy on May 18, together with the reopening of exhibitions and cultural sites in the open and religious celebrations (with limited admissions). From this date, therefore, Italy has resumed a pseudo-normality during which it was however mandatory to respect the anti-contagion measures adopted. The beginning of face-to-face teaching activities was postponed to the 2020-2021 academic year, although from May 4 it was possible to carry out university exams on site and the high school final exams were allowed in presence, while the First Grade Secondary School exams were performed in remote mode. On May 25 the gyms reopened, and some sports activities restarted as well, except in Lombardy, where the sports centres resumed their activities from June 1. On June 8, Immuni, a mobile application, downloadable on a voluntary basis, started the testing phase in four regions: Abruzzo, Liguria, Marche and Puglia. This application alerts the user if he has been in contact with a person infected with COVID-19, if the latter has also used the app. Sports events and competitions of national interest resumed starting from June 12, but still without an audience.

- *June 15 (Phase 3/Coexistence with COVID-19):* On June 11 a new Prime Ministerial Decree was published, in force from June 15 to July 14, which further eases the containment measures. The access of minors to indoor and outdoor places intended for playful activities was allowed with the presence of operators; arcade, betting and bingo halls reopened; shows open to the public were allowed in theatres, cinemas and concert halls, with a maximum of two hundred spectators indoors and a thousand outdoors, with pre-assigned seats spaced at least one meter apart; the bathing establishments, wellness centres, cultural and social centres reopened; the conduct of the events was allowed only in static form. The DPCM leaved the regions free to further loosen or restrict these latter measures, as well as to postpone them, based on the epidemiological situation of each territory. From June 15, the use of the Immuni app has been made possible throughout the Italian territory. From June 25 it was also allowed to practice contact sports.

This list briefly summarizes the main decisions taken by the Italian government since the beginning of the health emergency. In particular, the first moments described represent the general context in which the working group found itself while formulating possible hypotheses for the scenarios of the model described in Chapter 4.

2.3.3 Assessing the economic impact of a pandemic

This Section is dedicated to the analysis of some of the already existing tools that can be used for approaching a pandemic scenario. Due to the outbreak of the health emergency, the months of February and March 2020 resulted in a period of strong societal change. There was a strong uncertainty about the future, with daily reports of increasing infections and deaths across the world raising people anxiety, the health and safety of families, friends, and loved ones for each individual was perceived as compromised, as well as the possibility of returning to conduct a normal life. In addition to the immediate concerns about the impact on the everyday life, there was fear about the severe economic downturn that may result from the battle against the novel pandemic, with businesses being shuttered and an increase of the unemployment rate. A McKinsey report published at the beginning of March 2020, named *“Safeguarding our lives and our livelihoods: The imperative of our time”*, confirmed this, adding also: *“In Europe and in the United States, the required “lockdowns” of the population and other efforts to control the virus are likely to lead to the largest quarterly decline in economic activity since 1933 [...] We see enormous energy invested in suppressing the virus [...] We also see enormous energy go into stabilizing the economy through public-policy responses. However, to avoid permanent damage to our livelihoods, we need to find ways to “timebox” this event”*. The Figure below, shows what the authors of this publication, supported by the Oxford University Economic Department, considered as the two biggest concerns that governments have to face:

- *Safeguard lives*: which can be briefed with the avoidance of the virus spread while sourcing for a better treatment and the vaccine. The main factor to be controlled in this case is the count of the total number of cases;
- *Safeguard livelihoods*: which translates into the commitment of governments to protect the economy, in particular the businesses most affected by the lockdown effects, together with the preparation for the return to a “partial normality” when the situation will be more favourable. A good measure of it is the GDP of the single country of which, however, a loss between the 8% and the 13% was considered a certain fact.

The imperative of our time

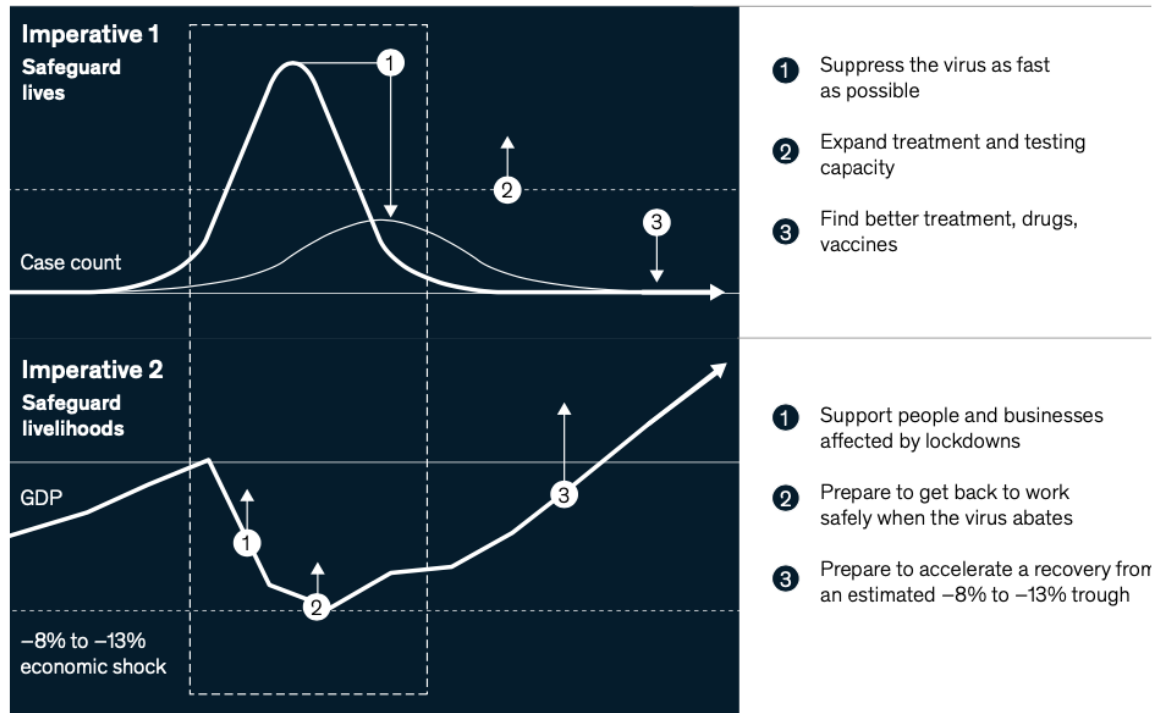


Figure 15: The two imperatives of our time (McKinsey, 2020)

In order to predict the impact of the health emergency in the immediate future, the authors introduced the concept of a multi-scenario model. This model generates nine different pictures about the magnitude of the pandemic outbreak, using the GDP as a general measure. These are generated by crossing two different dimensions:

- *Virus Spread and Public-Health Response*: of which three main archetypes of interventions and outcomes have been identified:
 1. A strong public-health response succeeds in controlling the spread of the contagions in each country within two to three months, so that physical and social distancing can be phased out quickly;
 2. Public-health response succeeds at first, but physical distancing has to continue (regionally) for several additional months to prevent viral recurrence;
 3. Public-health response fails to control the spread of the virus for an extended period of time, perhaps until vaccines are available, or herd immunity is achieved.
- *Knock-on Effects and Public-Policy Response*: of which three potential levels of effectiveness have been hypothesized:
 1. Ineffective: self-reinforcing recession dynamics kick in, with widespread bankruptcies, credit defaults and potential banking crisis;

2. Partially effective: policy responses offset economic damage to some degree, a banking crisis is avoided, but high unemployment and business closures mute the recovery;
3. Highly effective: strong policy response prevents structural damage to the economy, a strong rebound after the virus is controlled returns the economy to pre-crisis levels and momentum, as justified by the economy fundamentals.

The scenarios obtained by the combination of these two variables are observable in Figure 16. The authors also mention that “many currently expect one of the shaded scenarios, A1–A4, to materialize. In each of these, the COVID-19 spread is eventually controlled, and catastrophic structural economic damage is avoided. [...] Other, more extreme scenarios can also be conceived, and some of them are already being discussed (B1–B5). [...] With the number of new cases expanding exponentially in many countries in Europe and in the United States, we cannot exclude these more extreme scenarios for now.”

Scenarios for the economic impact of the COVID-19 crisis

GDP impact of COVID-19 spread, public-health response, and economic policies

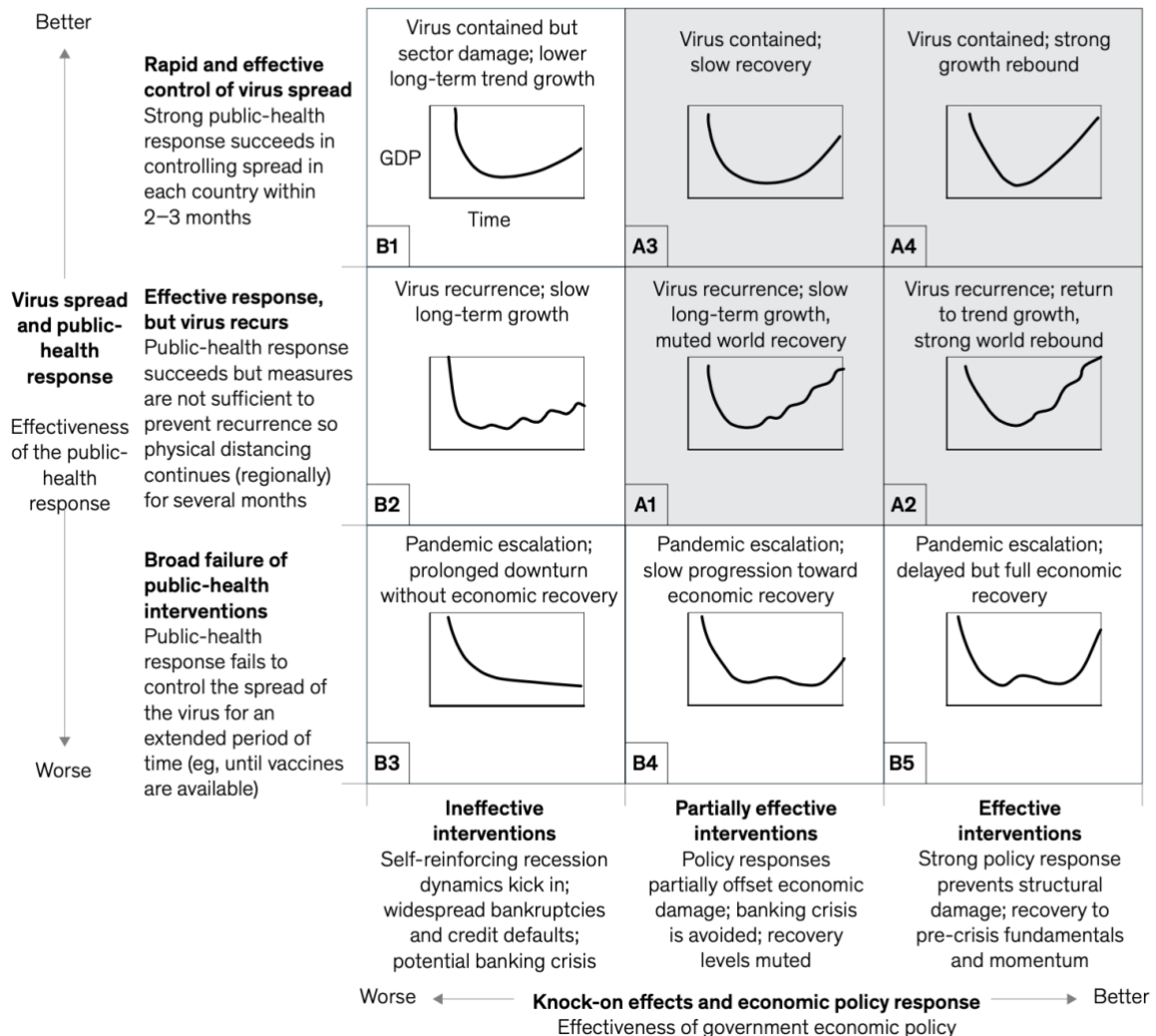


Figure 16: Scenarios for the economic impact of the COVID-19 crisis (McKinsey, 2020)

If, on the one hand, this model considers a general picture and it is still at a macroeconomic level, on the other hand, due to the novelty and uncertainty of the environment, this approach has been considered the ideal one in order to approach the complex situation that cultural institutions were facing as well. Even if Chapter 4 will enter into details of this choice, it is possible to anticipate that this way of proceeding with different scenarios has been of inspiration for the working group.

For what concerns museums, a direct testimony is provided by Antonio Tarasco, the Director of Service I of the Directorate General for Museums of the Italian Ministry of Cultural Heritage and Tourism. He judged the impact of COVID-19 over museums as *“not happy at all [...]. We have a revenue production method based mainly on ticketing. Therefore, the interruption of the service immediately leads to the suppression of about 90% of revenues, while the other 10% is related to ancillary services (e.g. bookshops)”*. According to ISTAT, almost 55 million people visited state museums in 2019, with revenues of about 243 million euros. The monuments and archaeological areas welcome more than half of the total number of visitors (almost 29 million). A quarter of the people (14 million) were concentrated in museums while 21.3% (almost 12 million) have purchased an integrated ticket to visit the structures of museum circuits (82.9 million euros in revenues). Moreover, last year monthly data on the flow of visitors to state museum institutions show that the peak of admissions occurred in the months of March, April and May. In this quarter alone, with 17 million 486 thousand accesses, equal to about 6 million users per month, the state structures welcomed almost a third (31.9%) of the total public in 2019. This seasonal trend, which represents a characteristic recurring over the years, affects the entire national territory: in the March-May quarter, in fact, a share of the annual total is concentrated equal to 34.7% of visitors for the North, 30.9% for the Centre, and 32.9 % for the South of the country.

The high influence of the revenues coming from tickets over the total sales is the biggest concern of the Director Antonio Tarasco, which also points out how, in other countries, this dependence from the box office is not so marked: *“Anglo-Saxon museums base the prevalence of their revenues on ancillary services, donations and merchandising. Then, there are the brands that are valued abroad, like the Louvre Museum which collects 400 million euros from the Arab Emirates”*.

This Master Thesis does not aim to help cultural institutions by redesigning a revenue system no more thoroughly dependent on entry tickets, however these data have been fundamental in order to choose the best parameters of measure for quantifying the losses that museums might occur due to the COVID-19 emergency. As a matter of fact, as initially hypothesized by the working group, the impossibility of performing regular museal activity and therefore to gain revenues from the entry tickets, actually represents the biggest concern of museums, at least for the Italian cultural heritage picture.

3. Methodology

This Chapter contains the description of the entire process that has been carried out in order to realize the initial purpose of this Master Thesis: developing a model capable of assessing the economic impact of the COVID-19 pandemic over cultural institutions. The goal is to give to the reader further insights about the approach adopted, the choices made and the reasons behind them.

This Chapter develops starting from the methodology to which the literature review has been performed, together with the gap identified and the respective research questions posed to fill it. Subsequently, the main considerations regarding the realization and application of the model are presented: the creation of the scenarios, the research of historical data and the analysis about the collected results. Moreover, the Chapter refers also to the main supporting tools used to bring to conclusion this research project.

3.1 Literature review and research questions

This Paragraph presents the process through which the literature review has been carried out. The existing literature is various and full of authors, with a large number of research available. The synthesis of the literature is commonly considered an essential process for knowledge widening, being it capable of providing new hints for the research and to demonstrate the presence of gaps. The main difficulties which have complicated the performing of this process can be grouped as belonging to three blocks:

- *The “distance” in terms of research topics:* the two main argument of research of this Master Thesis have been surely “museums” and “pandemic”. Despite the huge quantity of material available for both of the topics, it has been difficult, at least during the first months after the COVID-19 outbreak, to find papers combining the two fields. This was also probably related to the two following points of this list. Firstly, being this an exceptional situation, the attention shifted entirely on the pandemic itself, with the safeguard of people health and limiting the economic repercussions as the two fundamental priorities. To this extent, it was clear that the focus of the experts was initially posed on “the big picture”, trying to find a way to contain damages the most. Then, experts (both academic and non-academic) started to publish research and estimates about the impact of the pandemic on the various sectors and micro-sectors. Certainly, being the health emergency still ongoing, further field studies will be performed and published. However, one of the goals of the research was to provide museums with an instrument to help them in the reopening after the general Italian lockdown lasted from March to May 2020,

in order to also have the possibility to collect data for testing this tool and evaluating its goodness. What the working group did, was to try to stay as updated as possible with current studies and trends.

- *The newness and uncertainty of the context:* this component affected the insiders and the government, which was trying to develop ad-hoc regulations in order to fight the spread of contagions. It is therefore logic that, in the ambit of a project work related to COVID-19, the working group would have been affected by this uncertainty. Furthermore, the impact of this resulted increased by the fact that no member in the working group possessed humanistic or medical competences to tackle these topics with a critical point of view. In this sense, the literature review has been fundamental in order to cope this lack with required basic notions of these fields, in fact, if on the one hand this research does not want to provide guidelines at a strategic countrywide level, on the other hand it is impossible to deal with these issues ignoring their main features. Recalling some basic project management foundations, uncertainty is defined as “*ability to predict outcome of parameters of foresee events that may impact the project*” (B. Pernici, 2020), it is clear that moving forward towards the delivery of the project, uncertainty decreases. Since the objective was to provide the three collaborating institutions with a ready to use tool for their reopening, the timespan available for the working group was lower than the six months of emergency state declared by Italy as of January 31, 2020, and even lower if compared to most recent statements by WHO director general Tedros Adhanom Ghebreyesus who, referring to the previous Spanish flu pandemic, declared that “*it took two years to finish*”. In light of this, it is possible to state that the working group operated with a high level of external uncertainty. Figure 17 shows how, in projects, uncertainty decreases over time.

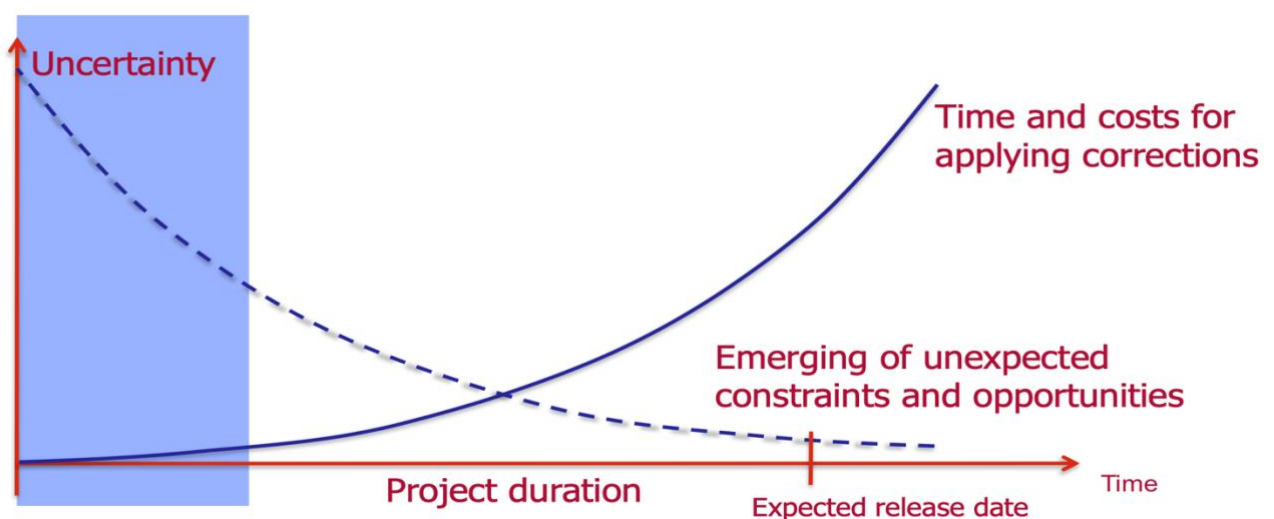


Figure 17: Uncertainty in projects (B. Pernici, 2020)

- *The focus of already existing contributions:* as showed in the first Chapter of this Master Thesis and subsequently in the literature review process, models discussing the potential economic impact that a pandemic might have are largely available, these come by both academic and non-academic sources (such as independent institutions or consulting firm reports). Nevertheless, even though these tools have been useful for gathering a general overview of the damages that the health emergency might bring, they do not entirely suit to the cases under analysis. Indeed, the model has been thought according to the reality of the three requiring museums, which represent a small part of the Italian cultural heritage mosaic. Compared to the macroeconomic level to which these scientific contributions are presented, the specificity of the developed model is sensitively higher, and this represented one of the biggest challenges for the working group.

What emerged from the literature review was the absence of direct assessments about what a pandemic might bring to cultural heritage, particularly a tool directly applicable and compatible with the numbers of a cultural institution. To fill the identified literature gap, the following research questions have been posed:

1. Which numbers or indicators can be used for assessing the economic impact of the COVID-19 over museums, that can be easily read but complete at the same time?
2. How is it possible to foresee potential evolution of the current scenario (as of March 2020)?

The attempt to answer these research questions led to the choice of adopting a multiple scenarios approach, taking into consideration both quantitative and qualitative aspects.

3.2 Gathering data and measurements

If the next Chapter is aimed to carefully explain all the formulas behind the model, this Paragraph provides some information about how these have been obtained and elaborated. Briefly, one of the main parameters that the model utilizes, is the number of visitors that each museum should have had during the year 2020, in absence of the COVID-19 health emergency. This is coherent with what presented in Section 2.3.3, in which it is underlined the strong dependence of Italian museums total revenues from the number of entry tickets sold. While developing the presented tool, it was therefore necessary to find a methodology capable of estimating this parameter. Furthermore, for this purpose, the working group also needed to find coherent sources of data to be elaborated. As regards the visitors, the Italian Ministry of Cultural Heritage and Activities and Tourism discloses yearly these types of data directly on its web page of statistics:

- *Paying visitors*: people that actually pay a ticket for visiting one of the cultural institutions. This data is usually reported as consumptive in the available statistics, however each museum has its own personal and staggered range of tariffs. As an example, the Table below reports the pricing adopted by the Gallerie Estensi for entering in their site of Modena.

Regular ticket	€ 6
FAI reduced ticket	€ 5
Reduced coop partner	€ 4
Reduced Teatro comunale di Modena	€ 3
Reduced young	€ 2

Table 8: Gallerie Estensi tickets price

- *Non-paying visitors*: indeed, it is common that certain categories of people may access to Italian cultural institution with a free ticket. The categories may vary according to each institution directives, but commonly this offer is thought for schools, people with disabilities and relative companion, journalists and tourist guides with card, young people under 18 years old, ICOM members, MIBACT⁷ staff, teachers and students.

Due to this heterogeneity as regards the revenue obtainable from the single ticket, the working group decided to take into consideration mainly the yearly number of visitors, easily obtainable by summing the number of paying and non-paying visitors. Then, starting from this it is also possible to quantify the total revenues that could have occurred. In addition to the data disclosed by the Ministry, the three collaborating museums provided reports about their individual situation about visitors and ticketing as regards the previous year 2019. Table 9 reports this picture as it concerns Gallerie Estensi, it is observable how both the revenues coming from entries and the entries themselves are not uniform, varying according to the period of the year. As a matter of fact, April and May together with the quarter comprehending October, November and December represents the months in which the highest number of visitors is reached, coinciding with the biggest portion of revenues. The same type of data as regards the Musei Reali of Turin and the Palazzo Ducale of Mantua are observable in the Appendix. What is possible to define with these numbers is a coefficient which, for each month, measures the revenue that the single visitor may bring. This can be computed by dividing the revenues from ticketing for the number of tickets sold, for each month.

⁷ Ministero per i Beni e le Attività Culturali e per il Turismo

$$\text{Monthly Revenue per Visitor Coefficient}_i = \frac{\text{Revenues from entry tickets}_i}{\text{Number of visitors}_i}$$

It is clear that, with this formula, paying and non-paying visitors are grouped within a single term, with the unit of measure expressed as Euros per visitor.

Month	Revenues	Number of visitors	Coefficient
Jan. 2019	€ 11,608.90	5,667	2.05
Feb. 2019	€ 7,518.50	5,657	1.33
Mar. 2019	€ 12,906.90	11,709	1.10
Apr. 2019	€ 32,529.20	13,596	2.39
May 2019	€ 21,715.40	9,660	2.25
Jun. 2019	€ 27,983.60	6,973	4.01
Jul. 2019	€ 11,905.50	4,142	2.87
Aug. 2019	€ 18,365.10	6,196	2.96
Sep. 2019	€ 19,255.30	16,121	1.19
Oct. 2019	€ 18,376.80	19,338	0.95
Nov. 2019	€ 17,035.60	16,811	1.01
Dec. 2019	€ 10,107.10	13,431	0.75

Table 9: Gallerie Estensi ticket revenues per month (2019)

The complete version of these data, comprehending also the numbers regarding the other two collaborating museums of Turin and Mantua, are consultable in the Appendix. The main source has been the repository consultable on the MIBACT website, even though the intervention of the three institutions has been necessary. Indeed, as of March 2020, the numbers regarding the year 2020 were still not published available on the MIBACT database, therefore the working group obtained this information directly from the three museums interested. In addition to the respective 2019 situation concerning revenues and their split across each single month, a further required insight has been the distribution of museums visitors across the Italian national territory, of which the proper utilisation will be shown in Chapter 4. These data come from a 2019 survey conducted by Politecnico di Milano, in the ambit of a project work related to the Italian Museums Good Practices, in which each of the three institutions contributing to the development of this model was involved. Due to the peculiarity

and the timing required to provide these data, it would have been difficult for the working group to gather all this information without a strong participation of the requiring parties.

A step forward into the development of this model, is represented by the choice regarding the modality in which obtaining further knowledge form the data gathered. The objective of the working group was to find a reference value, at least in terms of visitors, that should have been the base to which calculate the potential losses due to the pandemic. Having available historical data regarding the yearly visitors, the choice fell on building a bivariate linear regression model, capable of forecasting the expected number of visitors as function of time. The aim of this instrument is to describe a population through a linear equation, the simplest of which is represented by:

$$Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i \quad \forall i = 1 \dots n$$

The terms of this equation represent respectively:

- i : it is the single observation;
- Y_i : it is the dependent variable (in this case the number of visitors);
- X_i : it is the explanatory variable or regressor (in this case it represents a certain year);
- β_0 and β_1 : they are the population regression coefficients;
- ε_i : it is the error term or residual, with the assumption that $E[\varepsilon] = 0^8$ and $E[\varepsilon|X_i] = 0^9$ for all i .

A graphical representation of the bivariate linear model is provided in Figure 18 below.

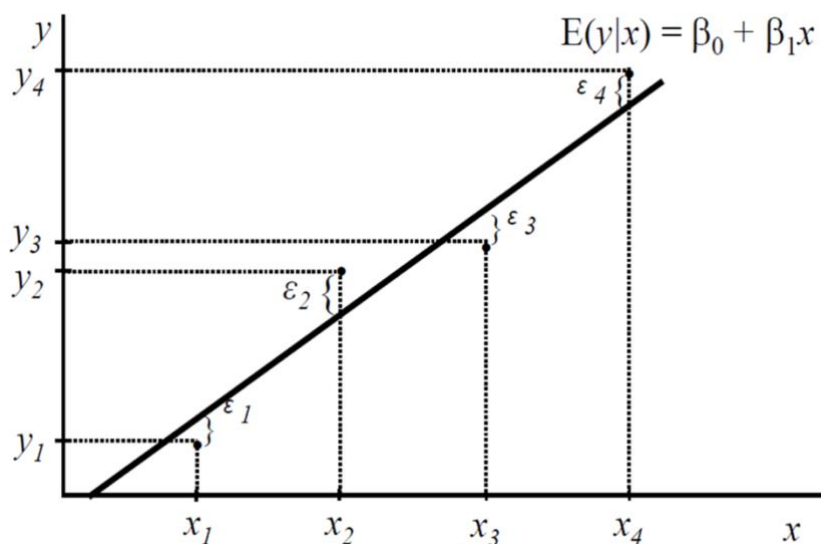


Figure 18: The bivariate linear model

⁸ The expected value of ε is equal to zero

⁹ The expected value of ε given X is equal to zero

Having said that means that the population follows the linear equation previously introduced, with β_0 and β_1 representing the coefficients that describe the true relation between X and Y. These are not known, but it is possible to obtain an estimate using different techniques. In order to build a linear regression model for forecasting the potential number of visitors that museums could have had in normal conditions (i.e. in absence of the pandemic outbreak), the Ordinary Least Square method has been adopted. The OLS¹⁰ method consents to build the following regression:

$$\hat{Y}_i = \hat{\beta}_0 + \hat{\beta}_1 X_i + \hat{\varepsilon}_i \quad \forall i = 1 \dots n$$

Inside this linear equation it is possible to define:

- $\hat{Y}_i = \hat{\beta}_0 + \hat{\beta}_1 X_i = E[Y_i | X_i]$ $\forall i$: it is the predicted value of Y_i conditioned X_i . \hat{Y}_i is also called the within-sample forecast of Y_i ;
- $\hat{\varepsilon}_i = Y_i - \hat{Y}_i$: it is the residual, which measure the distance of Y_i from its forecast \hat{Y}_i (for each observation i);
- $\hat{\beta}_0$ and $\hat{\beta}_1$: they are the estimators that minimize the sum of squared residuals, which can be computed respectively:

1. $\hat{\beta}_1 = \frac{\hat{\sigma}_{XY}}{\hat{\sigma}_X^2} = \frac{\frac{1}{n-1} \sum_{i=1}^n (X_i - \bar{X})(Y_i - \bar{Y})}{\frac{1}{n-1} \sum_{i=1}^n (X_i - \bar{X})^2}$: it consists of the sample covariance between X and Y divided by the sample variance of X. This result can be obtained by imposing the first order condition in the minimization equation for the sum of squared residuals;
2. $\hat{\beta}_0 = \bar{Y} - \hat{\beta}_1 \bar{X}$: it represents the constant term of the equation. It is obtainable using \bar{Y} and \bar{X} , which are estimators for the unconditional means of Y and X.

Moreover, for the OLS estimators two further conditions hold:

- $\bar{\hat{\varepsilon}} = \frac{1}{n} \sum_{i=1}^n \hat{\varepsilon}_i = 0$: the estimator for the unconditional mean of the residual is equal to zero;
- $\bar{\hat{Y}} = \frac{1}{n} \sum_{i=1}^n \hat{Y}_i = \bar{Y}$: the estimator for the unconditional mean of the within-sample forecast is equal to the estimator for the conditional mean of Y.

As regards the regression performed in the ambit of this model, it has been considered an interval of six years between 2014 and 2019, in order to forecast the expected number of visitors for 2020. The choice of this interval has been taken jointly with the three institutions under analysis, being 2014 a year full of changes for these museums. In fact, as mentioned in Paragraph 2.2, it is of this year the Decree of the President of the Council of Ministers including these three museums in the list of

¹⁰ Ordinary Least Squares

institutions with special autonomy. Due to this, when searching for data before 2014, it might have been possible to incur in mistakes related to the way in which data were registered before the changes undergone after the Decree. As an example, smaller museums and collections already existing as separate institutions were added to the biggest museal circuits represented by the three museums under analysis after 2014, making complicated and not uniform the research of data about visitors. Therefore, the working group and the personnel of the three collaborating institutions, retained sufficient to consider an interval of six years.

Concluding this brief deepening on the OLS method, it is also necessary to have an indicator about how well the model predict the observed data. Every observation consists of an explained part and an unexplained part and under OLS the two are orthogonal, as stated in the following formula:

$$Y_i = \hat{Y}_i + \hat{\varepsilon}_i$$

It is then possible to decompose the variance of the dependent variable Y:

$$TSS^{11} = \sum (Y_i - \bar{Y})^2 = \sum (\hat{Y}_i - \bar{Y})^2 + \sum \hat{\varepsilon}_i^2 = ESS^{12} + SSR^{13}$$

Writing the overall variation in Y in this way (TSS), means that this can be obtained by summing the variation explained by the regression model (ESS) and a component of variation which remains unexplained (SSR). As a matter of fact, it is possible to use a coefficient of determination, named R^2 , in order to evaluate the goodness of the model in explaining data:

$$R^2 = \frac{ESS}{TSS} = 1 - \frac{SSR}{TSS}$$

This indicator is defined as the ratio between the variation explained by the model and the total variation occurred. The main features of R^2 are:

- The larger it is, the better does the model explain the variation in the dependent variable Y;
- It holds that $0 \leq R^2 \leq 1$;
- If R^2 is equal to zero, it means that ESS is equal to zero as well and the regression has no explanatory power;
- If R^2 is equal to one, it means that either ESS is equal to TSS or SSR is equal to zero. This implies that the dependent variable Y is entirely explained by the model.

¹¹ Total Sum of Squares

¹² Explained Sum of Squares

¹³ Sum of Squared Residuals

3.3 Supporting computing tools

This short Paragraph is dedicated to briefly mention the informatic instruments which have been deployed when performing the research and, subsequently, the analysis of the necessary data.

The most used software has been Microsoft Excel, the widely used program as regards the production and management of spreadsheets: “since its introduction in February 1991, the Microsoft Excel Solver has become the most widely distributed and almost surely the most widely used general-purpose optimization modelling system” (Fylstra et al., 1998).

It is therefore natural that all the data disclosed by the Italian Ministry of Cultural Heritage and Activities and Tourism are published in this format, as well as the data directly transmitted by the three collaborating museums. In the face of this, all the computations concerning each scenario identified have been realized using this supporting computing tool.

However, the auxilium of software has not been limited to the usage of the most common program of spreadsheets. Indeed, for supporting the calculations related to the aforementioned regression models about the expected number of visitors, even the statistical software gretl has been used. Even though, in its early versions, gretl was particularly oriented in the analysis of time series, this tool is now widely used in econometrics and statistical analysis, with its current versions offering a rather complete spectrum of modern statistical methods. Figure 19 below shows the output of the program, after having performed a linear regression with OLS estimators. In this case the data analysed are the visitors from year 2014 to 2019 of the Gallerie Estensi of Modena, considering 2014 as “year 1” and 2019 as “year 6”.

Model 1: OLS, using observations 1–6
Dependent variable: Visitors

	coefficient	std. error	t-ratio	p-value	
const	39311.2	15261.5	2.576	0.0616	*
Years	13481.1	3918.79	3.440	0.0263	**
Mean dependent var	86495.00	S.D. dependent var		29173.37	
Sum squared resid	1.07e+09	S.E. of regression		16393.46	
R-squared	0.747386	Adjusted R-squared		0.684232	
F(1, 4)	11.83441	P-value(F)		0.026291	
Log-likelihood	-65.52506	Akaike criterion		135.0501	
Schwarz criterion	134.6336	Hannan-Quinn		133.3829	

Figure 19: OLS output for the Gallerie Estensi of Modena using gretl

Having a further analysis tool in addition to Microsoft Excel, permitted to the working group to dispose of an alternative confrontation and to deal with the numbers of the three collaborating museums in an even easier way.

Concluding, the benefits of working with gretl are also highlighted by academics and scholars belonging to the statistical and mathematics fields. As stated by Wilson Mixon and Smith (2006): *“GRETL can be a useful research tool. Much of what applied econometricians do can be accomplished directly within GRETL. [...] Researchers requiring only ordinary least squares and generalized least squares techniques will find GRETL both adequate and accessible”*.

4. The Multiple Scenarios Model

In the literature review, the reasons behind the development of the model have been illustrated. Indeed, there are models aimed to estimate the impact of a pandemic, which take into consideration scenarios and data from previous emergency situations, already existing. Moreover, it is clear that several institutions, from universities to consulting firms and analysts, will monitor the situation, providing updated numbers as well as forecasts of the impact of COVID-19, moving from the economic sectors to the societal changes that the health emergency brought.

If, on the one hand, this ocean of publications and research is fundamental for each individual and not only as regards a particular sector like cultural heritage for gathering an orientation about the future complications due to the pandemic development, on the other hand, in order to answer to the explicit request of the three northern Italian museums, the step into the construction of a more specific tool was considered a necessity both from the museums practitioners side and the working group. The model presented in this Chapter can be considered as a “niche” model, which targets the Italian museums sector with data directly gathered from the field.

Therefore, this Chapter wants to explain the realized Multiple Scenarios Model to the reader, it is divided in three parts to better organize the understanding of this tool functioning. It begins with an overview of the situation in Italy as of March 2020, recalling what said in Section 2.3.2 and contextualizing it to the development of the presented instrument. The second part presents the schema according to which the model works, deepening each single parameter used and the hypothesis made. It also provides the actual forecasted number obtained by the application of the model to the situation of the three northern Italian museums. Concluding, the third part proposes a generalization of the developed model, extending its application to a wider context, not constrained to be linked to the Italian cultural heritage situation only.

4.1 The conditions of the Italian culture after the pandemic outbreak

Recalling what presented in Section 2.3.2, the Decree of the President of the Council of Ministers of 23 February has effectively placed a blockade for the entire Italian cultural sector. As a matter of fact, literally quoting one of the points of the law, what emerges is a *"suspension of the opening services to the public of museums and other cultural institutes and places [...], as well as the effectiveness of the regulatory provisions on access free or free to such institutions and places."*

This provision extended until March 1, which is why Italian museums were able to reopen for the first week of this month. However, it is a known fact that the measures taken were not sufficient to

improve the health situation which, on the contrary, was constantly worsening. As shown in Section 2.3.2, between 7 and 9 March the Presidency of the Council of Ministers formalized the measures that led to the generalized lockdown of the entire nation, extending the closure provisions of common retail commercial activities to all of Italy, educational activities, catering services and prohibited the gathering of people in public places or places open to the public. These were already valid from 8 March in the Lombardy region and in the provinces of Modena, Parma, Piacenza, Reggio nell'Emilia, Rimini, Pesaro and Urbino, Alessandria, Asti, Novara, Verbano-Cusio-Ossola, Vercelli, Padua, Treviso, Venice.

In this context, museums had to try to prepare for new ways of cultural enjoyment, both during the period of total closure (e.g. by increasing their presence on social media or by offering the public "virtual tours"), and in the face of the need to prepare for a future opening coinciding with a "Phase 2" of the pandemic emergency, in which the population is ready to agree with the presence of the virus and the institutions are able to diagnose, treat and isolate cases of COVID-19 and their contacts (N. Grassly et al., 2020). This, however, seemed to be still uncertain, being the only reference date available that of the end of the DPCM, corresponding to April 3, 2020.

The scheme contained in Table 10 represents the first step undertaken by the working group to model the context in which Italian culture suddenly found itself due to the health emergency.

	Opening	Closure	Reopening (Phase 2)
Visitors	Certain data	0	Forecast of expected visitors
Revenues		€ 0.00	Forecast of the revenue loss due to the number of visitors

Table 10: Preliminary reference schema for the model

At this point, the answers to three key interrogatives have been identified as a crucial node for building the model presented in this Master Thesis. These questions are quickly listed here and will be treated in greater detail within the next Paragraph:

1. *Who will be able to visit the museum at the reopening?* Despite the strong uncertainty as regards the actual date of the reopening, what was clearly imaginable and suggested, was the fact that the reopening would have been a gradual process and not a total comeback to the pre-emergency normality. To this extent, the concepts of Italian "Region" and "Province" have been exploited;

these, together with the Municipalities, Metropolitan Cities and the State itself, represent the five constitutive elements of the Italian Republic and can be intended as “administrative borders” (ISTAT, 2018). The hypothesis of progressive reopening has been formulated using these borders to mark the progressive increment of available audience willing and capable of visiting the museums. This increase of potential public is function of the fact that, if the pandemic conditions will improve, the government will potentially increase the possibilities of people to move across these boundaries, until the point in which travels in the entire country will be allowed (even in absence of a particular motivation), restoring a mobility situation similar to the one previous to the COVID-19 outbreak.

2. *How many visitors will there be at the reopening?* It is possible to forecast the number of expected visitors as regards 2020 using statistical techniques, however this number alone has not been considered as sufficiently precise to estimate the losses occurred in reasons of the pandemic emergency. Indeed, it is necessary to take into consideration the differences in terms of visitors presence across the months of the year, as mentioned in Section 2.3.3 and Paragraph 3.2, as well as the fact that the frequentation of museums after the attended reopening will be affected by the graduality of the process of return to normality. As concerns this latter component, museums made available data about the attendance of the first week of March 2020, in absence of the containment measures despite the emergency outbreak, which have been used as base to compute the initial number of visitors that these institutions will welcome at the reopening.
3. *How will the number of visitors grow?* The process of answering this interrogative led to the understanding of the necessity to build a model based on different scenarios. Being the growth of visitors mainly influenced by the mobility conditions, these pictures are realized taking into considerations two main components. The first, is the mobility allowed by governmental institutions. As previously mentioned, for this component the Italian administrative borders have been considered as a good proxy of what could happen in the future: the more the health conditions will improve, the larger will be the boundaries in which individuals will be able to move without restrictions. The second component, instead, is related to a more socio-psychological aspect. Several experts wonder about the impact of the restrictions activated as a response to the health emergency on the society in general, Zignale (2020) mentioned that: *“It is clear that in a context of restriction of mobility, in addition to the various physical and real movement implications of the individual, a fundamental part is reserved for the psychological aspect that the restriction imposes. Feeling limited, suddenly, by an institutional restriction, due to a global health alarm, which blocks daily mobility, determines, on a psychological level, the degree of emergency we are about to face.”* Bertocci et al. (2020) also point out that the fear sown by the

contagion from COVID-19, which has hit most in urban centres due to the greater density and mobility of the population, will continue to constitute a fundamental socio-natural relational element in infra, inter and extra-urban life. The multi-scalar volume of mobility, from micro to transnational, brings consequences for safety, the environment and health. Therefore, it will be necessary to re-imagine new methods of transportation. Giungato (2020) refers to a state of persistent fear in which the common citizen has found himself immersed in the days of lockdown, alimanted by the continuous succession of alarming and crude images. One above all, the procession of wagons of the Italian Army that leads to cremation the bodies of the dead, crossing in silence a night and deserted Bergamo, comparing this image to the image described by Manzoni in the novel *“I Promessi Sposi”* (1827), of the cart completely covered with naked corpses and marked by evident signs of the disease, crossing the streets of Milan during the plague epidemic of 1576. These are the reasons which lead the working group to include also a coefficient aimed at taking into consideration the willingness of people to move and its growth month after month. Figure 20 provides an overview of the 24 scenarios identified crossing these dimensions, the x and y axes relates to the mobility scenarios allowed by the government, presenting an expected date for the regional mobility (y axis) and then the national mobility (x axis). This Cartesian plane is replicated three times, once for each level of the aforementioned Growth Rate, of which a value equal to 5% has been identified as pessimistic, 10% as intermediate and 20% represents the most optimistic point of view.

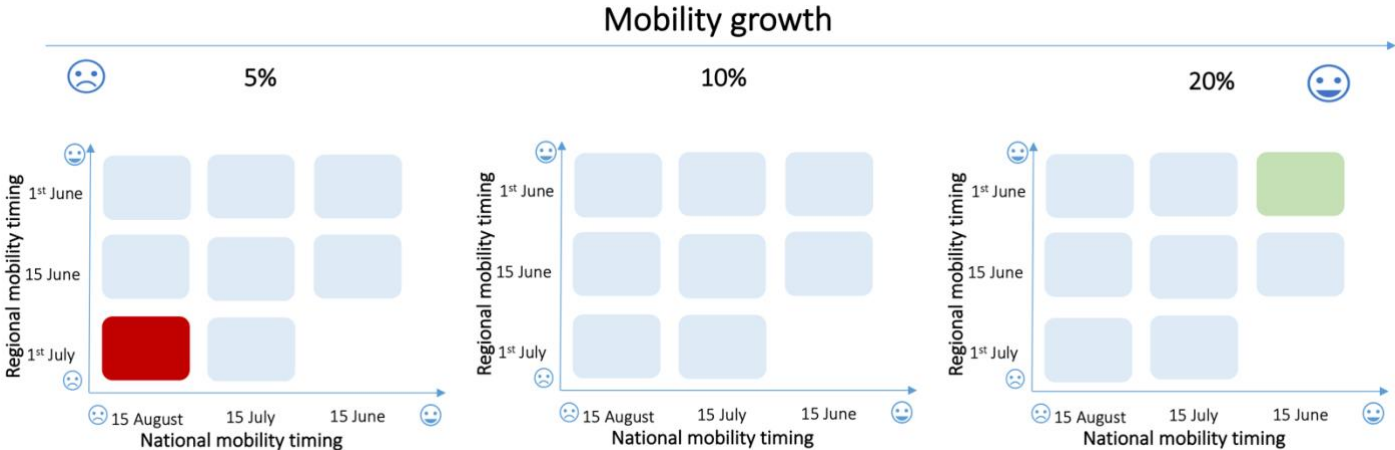


Figure 20: The different scenarios identified

In this representation, the red block constitutes the most pessimistic scenario, in which the possibility of an individual to move inside its home Region is denied until July 1 and the mobility

around the national territory will be allowed only after August 15, with a Growth Rate imposed equal to 5%. On the other side, the green block is equivalent to the most optimistic scenario, with regional mobility allowed from June 1 and the permission to travel around Italy starting from June 15, together with a Growth Rate equal to 20%. The dates used were chosen consistently with the measures adopted by the Italian government. In fact, a further extension took place on April 2 to April 13, which took place through a new Prime Ministerial Decree. Subsequently, after the Prime Minister conference on April 10, the measures were extended until May 3.

4.2 Results of the model application

This Paragraph is dedicated to the presentation of the numbers obtained by the application of the Multiple Scenarios Model under analysis to the three museums which contributed to the realization of this research project. The previous Paragraph briefly described the mechanism of working of the model: by crossing two different dimensions related to mobility after the attended reopening, 24 different scenarios are generated, to which different economic impacts are associated. However, in order to satisfy the goal of this Master Thesis, it is also necessary to answer a fourth question: “*How to convert these results into economic terms?*”. The economic assessment is indeed the final objective for which the Multiple Scenarios Model has been developed.

This Paragraph is therefore divided in two further Sections, which have the goal of deepening the underlying hypothesis and show the computations behind the forecasts obtained respectively. However, before moving into these more technical aspects, a synthesis of the results obtained is presented to the reader in Figure 21.

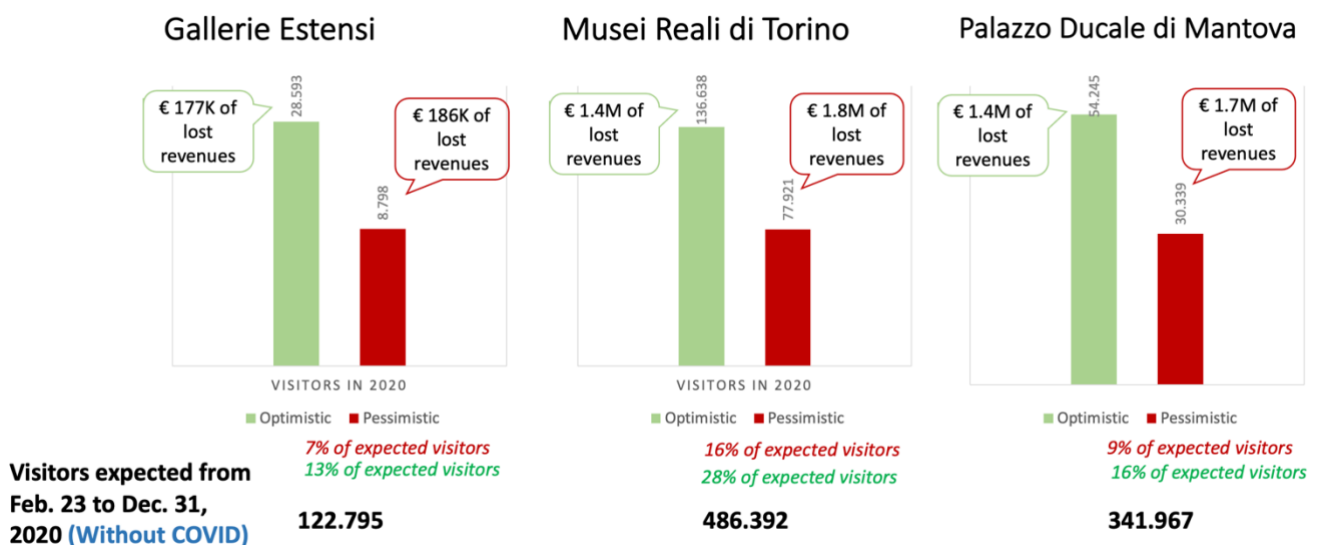


Figure 21: Synthesis of the results obtained by the model application

Precisely, the Figure contains two key indications as regards this research project. The first, readable on the bottom of the picture, is the number of visitors forecasted to be expected in the rest of the year 2020, in absence of the COVID-19 pandemic. Further clarifications on this number will be provided in the following Sections, briefly this estimate is obtained through a linear regression, made with the OLS method, using data regarding the entries registered in the previous years by museums and subtracting to this number the visitors who attended in in January and in the first three weeks of February. This number represents the estimated residual of visitors that might have come to museums, if 2020 would have been a “common year” without any extraordinary situation. As a matter of fact, being January and February not affected by the measures undertaken as response to the health emergency, it is necessary to exclude them to the forecasted calculated on the entire year, in order to obtain the residual for the remaining months. The second, observable in the bar charts, refers to the forecast of visitors who will enter the museums after the first day of reopening, up to the last day of 2020. As previously mentioned, this number varies according to each scenario considered, what Figure 21 shows are the numbers relating to the most optimistic and the most pessimistic scenario respectively. These, for each institution, correspond to the green column and the red column, and can be defined as the numerical projection of the conditions that the green block and the red block comport (Figure 20), which have been discussed in the previous Paragraph. A label is attached to each column, containing the translation in terms of lost revenue, the explanations and subsequent calculations are provided in the following two Sections.

4.2.1 The underlying hypothesis

This Section resumes the questions posed in the previous Paragraph and presents the assumptions adopted by the working group in order to answer them and model scenarios that the three institutions might encounter after the reopening.

Starting with the interrogative about the people that will be allowed to visit the museums, it has been clear since the beginning that the participation in cultural activities would have been related to the mobility allowed within the various territorial areas. In this sense, as already mentioned in Paragraph 4.1, the Italian “administrative borders” have been exploited, dividing the permitted mobility into three different levels of extension: Province, Region and Nation. It was therefore necessary to gather a numerical assessment about the geographical provenance of museums visitors and, to this extent, it has been exploited a Project Report about Museums Good Practices, conducted by Politecnico di Milano in 2019. The Report has multiple goals, being it oriented to the return of the results of the investigations carried out in 2019 about customer satisfaction with current audiences, an analysis on the various social media channels and a study on the digital positioning of museums. Nevertheless,

even the researchers who contributed to the drafting of the document needed to have a picture about the geographical split of museums visitors. Therefore, the data provided by this research can be considered a reliable estimate as regards geographical provenance of the three institutions audience, with a synthesis of these observable in Table 11. As regards the percentage contained in each cell, when moving from a smaller area of mobility to a wider one, the latter contains all the visitors included in the previous. As an example, the 29% of regional visitors for the Gallerie Estensi of Modena includes the percentage of 19% of visitors coming from the Province. The fact that the ending column, which relates to the visitors from the whole Italian territory, does not shows values equal to 100%, is due to the fact that each of the three museums presents a component of foreign visitors.

	Province	Region	Nation
Gallerie Estensi	19%	29%	90%
Musei Reali	42%	46%	96%
Palazzo Ducale	15%	42%	95%

Table 11: Division of the audience geographical provenience for the three museums

After having done this, it was necessary to deal with the question about the quantity of visitors that the reopening would likely have brought to the three collaborating institutions. A first step in this direction has been the computation, by means of a linear regression performed with OLS method, of the expected 2020 visitors. The estimate, as mentioned in Chapter 3, has been performed over an interval of six years of historical data about museums registered entries. The numbers obtained have to be read as the entries that museums would have had in a condition of normality, if the pandemic outbreak would not have happened in 2020. The following Figures present a plot over years of the visitors occurred, as well as the linear regression line for each of the collaborating institutions. A further version of these calculations is consultable in the Appendix, which shows to the outputs obtained by means of the econometrical software gretl, containing all the necessary coefficients estimated for these forecasts.

It is observable how, for each of the museums considered, the number of visitors in in constant growth from a year to another. This confirms the increasing trend as regards Italian cultural institutions number of visitors mentioned by ISTAT in its report “*L’Italia dei Musei*” (2019).

Particularly, looking at each single institution, the number of visitors forecasted to be attended for the Gallerie Estensi of Modena has been equal to 133,678 and this result, as well as data concerning previous years, are showed in Figure 22.

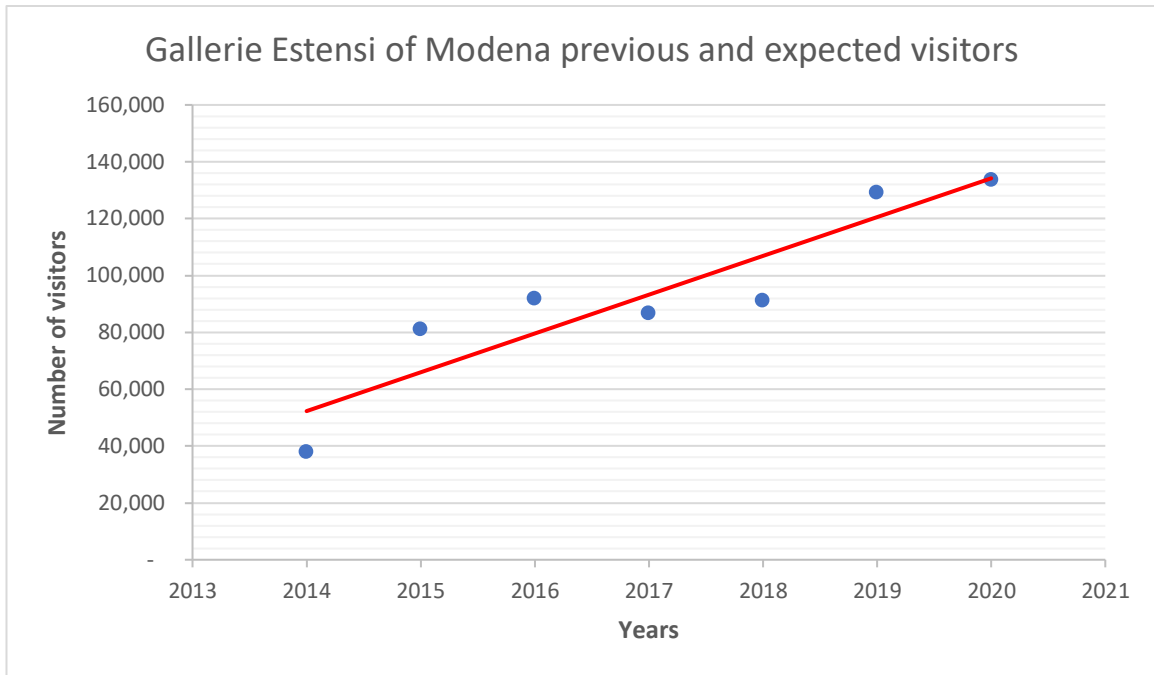


Figure 22: Linear regression for the Gallerie Estensi of Modena

The forecasted number of visitors for the Musei Reali of Turin, instead, is equal to 537,235 (Figure 23).

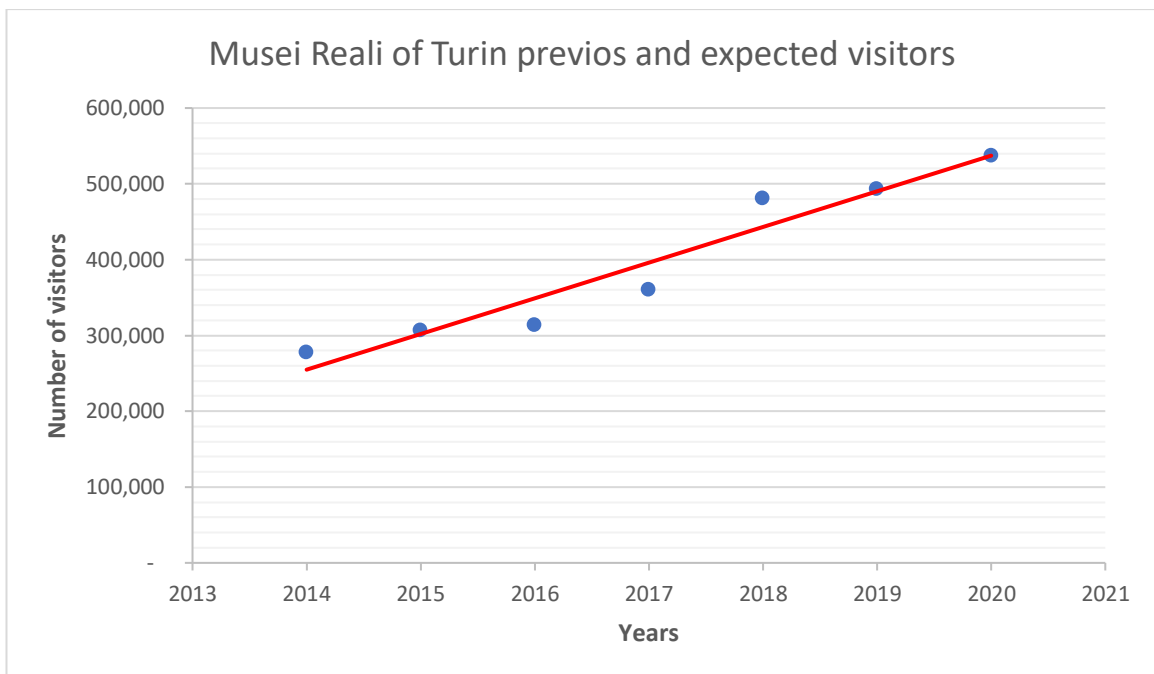


Figure 23: Linear regression for the Musei Reali of Turin

Concluding, the institution of Palazzo Ducale of Mantua was expecting to welcome 371,090 visitors, if 2020 would have been a common year (Figure 22).

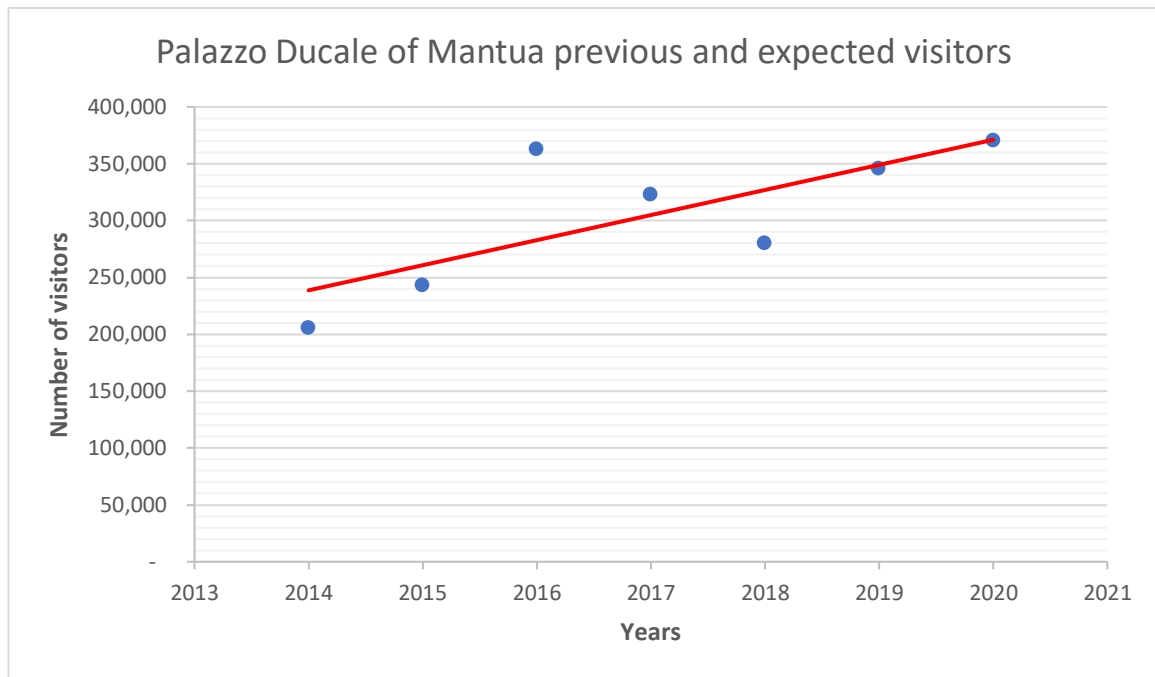


Figure 24: Linear regression for the Palazzo Ducale of Mantua

In this forecast, however, it is also necessary to take into consideration the differences that each month presents in terms of frequency of visitors. In this sense, the museums themselves provided detailed data about the visits in 2019, making available data for each single month. Therefore, the weight that each of these has in terms of entries registered has been computed (Table 12).

Months	Gallerie Estensi	Musei Reali	Palazzo Ducale
Jan. 2019	4.4%	8.1%	4.6%
Feb. 2019	4.4%	7.6%	3.2%
Mar. 2019	9.1%	12.3%	11.8%
Apr. 2019	10.5%	9.8%	14.6%
May 2019	7.5%	8.2%	14.2%
Jun. 2019	5.4%	6.0%	5.7%
Jul. 2019	3.2%	5.7%	4.0%
Aug. 2019	4.8%	8.5%	6.9%
Sep. 2019	12.5%	7.3%	6.3%
Oct. 2019	15.0%	8.5%	10.0%
Nov. 2019	13.0%	8.6%	10.3%
Dec. 2019	10.4%	9.4%	8.5%

Table 12: Impact of each month in terms of visitors for each museum

In light of this, expected visitors are forecasted considering the annual growth trend (computed with the previously mentioned linear regression), but assigning the same weight as last year monthly allocation. Although the exact calculations will be showed in the next Section, as an example it is possible to consider March and state that, for this month , the number of expected visitors without the presence of the COVID-19 emergency is obtainable by multiplying the coefficient 9.1% (for the Gallerie Estensi) for 133,678 (that represents the forecasted expected visitors for Gallerie Estensi over 2020), which leads to a number of 12,105 visitors that this museum, would have registered without the existence of the health emergency.

Moving forward, two main components were necessary in order to proceed with the modelling: the number of visitors that museums would have found in the very first days of their reopening, and a mathematical law that describes the growth of visitors over time. As concerns the first component, again, the data provided by the three cultural institution proved to be fundamental. Indeed, thanks to these, the working group retained reasonable to assume that the initial entries during the reopening will be similar to the ratio between the number of visitors in the first week of March 2020 (in presence of COVID-19) and the estimated number of visitors in the first week of March 2020 (in absence of COVID-19). This “Participation Rate” is obtainable applying the following formula:

$$Participation\ Rate = \frac{Actual\ visitors\ 1^{st}\ week\ of\ March\ 2020\ (COVID)}{Expected\ visitors\ 1^{st}\ week\ of\ March\ 2020\ (no\ COVID)}$$

Of which the data and respective results for each collaborating museum are available in the following Table 13.

	Gallerie Estensi	Musei Reali	Palazzo Ducale
Expected visitors 1st week of March 2020 (no COVID)	3,312	20,539	8,412
Actual visitors 1st week of March 2020 (COVID)	171	3,204	662
Participation Rate	5.16%	15.50%	7.87%

Table 13: Participation rate for each collaborating institution

On the other hand, the second component is related to the growth of the number of visitors after the reopening, which leads to the formulation of the different scenarios. As introduced in Paragraph 4.1, two main factors have been taken into consideration:

- *Mobility timing*: which refers to the dates in which, likely, the containment measures will be released and the area in which an individual can move (without a specific motivation) will be enlarged by the new ministerial decrees. For this purpose, the Italian administrative division in Provinces and Regions has been used and the general scenarios identified, according to this dimension, are showed in Figure 25;
- *Propension to travel*: it has been considered reasonable to suppose that, even though it will be legally permitted, the willingness of people to leave their homes for travelling will be, somehow, smoothed by the facts happened in the last months of pandemic emergency. Therefore, regardless the level of allowed mobility, it has been supposed that the number of visitors will grow linearly over time, with three different values of a “Growth Rate”, which highlights how visitors increase in a month with respect to the previous one.

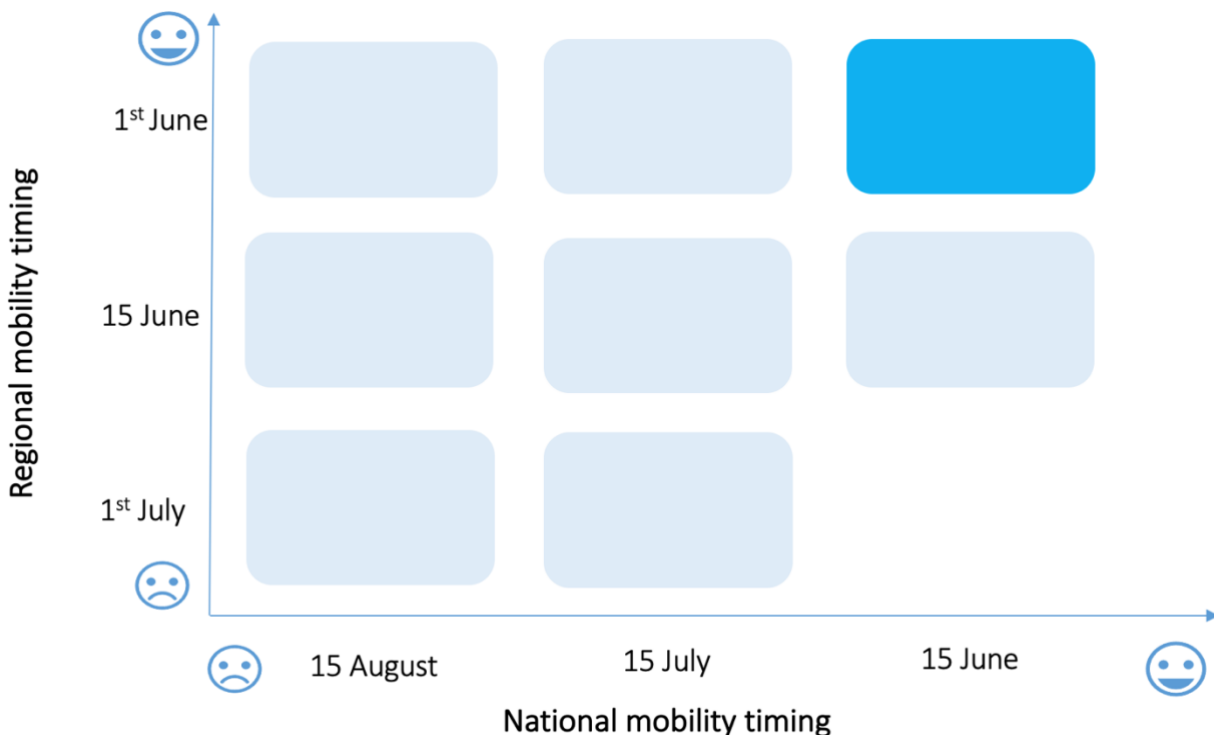


Figure 25: The different mobility scenarios

Considering as an example the block marked in blue, the translation in terms of likely scenario is that from June 1, 2020 it is possible to move freely within the Region for cultural visits and from June 15, 2020 the museums can have visitors from other regions (people might come from every part of the

country). As a result, a fraction of potential regional visitors will arrive from June 1 and, starting from June 15, also a fraction of national ones.

Month by month, the percentage of visitors, out of potential ones, grows linearly. Taking June as first month in which regional mobility is permitted, it is possible to compute the number of expected visitors as:

$$\# \text{ visitors June 2020 (COVID)} = \# \text{ visitors June 2020 (no COVID)} \times \text{Participation Rate}$$

The first component is obtainable considering the trend identified with the linear regression and multiplying it for the number of visitors occurred in June 2019, in order to take into account differences of each month in terms on impact over the registered entries, as previously highlighted in Table 12. The second component, instead, is the above-mentioned ratio between the visitors occurred in the first week of March 2020 and the visitors that should have been registered in absence of the COVID-19 pandemic outbreak.

The linear growth component enters starting from the second month of reopening, the formula used has been:

$$\# \text{ visitors month}_i \text{ 2020 (COVID)} = \# \text{ visitors month}_i \text{ (no COVID)} \times \text{Participation Rate} \times (1 + \text{Mobility Coeff.}) \times (1 + \text{Growth Rate})^i$$

In this equation, the Mobility Coefficient is function of the different scenarios, of which all possible values for each collaborating institution can be read in Table 14. The value increases when the containment measures are released. As an example, considering the Gallerie Estensi of Modena, when the barriers to national mobility are released and people are free to move in the entire national territory, the potential base of visitors moves from 19% of the total (the case in which it is only allowed to move within the Province of residence) to 90% (Table 11). Therefore, the Mobility Coefficient is computed with the following formula, when the possibility of movement within the regional territory is allowed by governmental institutions:

$$\text{Mobility Coeff.}_{\text{Regional}} = \% \text{ visitors in the Museum Region} - \% \text{ visitors in the Museum Province}$$

The formula changes when modelling the amount that a return to the possibility of freely moving on the entire national territory will bring in terms of potential audience available:

$$\text{Mobility Coeff.}_{\text{National}} = \% \text{ of Museum national visitors} - \% \text{ visitors in the Museum Province}$$

	Gallerie Estensi	Musei Reali	Palazzo Ducale
Δ visitors from regional reopening	10.82%	4.32%	27.27%
Δ visitors from national reopening	71.83%	54.32%	80.00%

Table 14: Mobility Coefficient values

The Growth Rate of visitors represents another dimension of the model and, as previously anticipated, this coefficient can assume three values: the pessimistic 5%, the intermediate 10% and the optimistic 20%. Concluding, the index i refers to the specific month and, since it is increasing, it represents the growth in terms of “willingness to move” that increases month by month. In this sense, referring to June as the month in which the reopening will take place, the growth is not perceived and, in fact, is not reflected in the formula. According to this schema, June can be indicated as “month zero” while the index i enters in the formula starting from July with value equal to 1, increasing by one unit as each month passes, until the end of the year.

4.2.2 Step by step computations

This Section provides details regarding the computations made as a consequence of the assumptions just presented. Since the scenarios generated by the model under analysis are 24 in total, providing details regarding each of these would excessively increase the length of this document, resulting in a too complex and heavy discussion for the reader. In order to avoid this, the computations here reported refers to a particular scenario, corresponding to the blue block in Figure 26. This situation is the one in which the regional reopening is assumed to happen on July 1, 2020, while the national one coincides with the half of the same month. As regards the growth of visitors over time, the calculations showed in this Section adopts a Growth Rate equal to 10%, representing therefore the intermediate situation. Moreover, the calculations enter in detail of the situation of the Gallerie Estensi of Modena, even if also the results regarding the other two cultural institutions are reported. This, again, in order to avoid the reader a useless lengthening of this Master Thesis document, being the technique used uniform for all the scenarios.



Figure 26: Situation considered as reference for presenting the computations

Calculations begin with estimating the number of expected visitors in June, in which it is assumed that only people resident within the Province of the Museum are allowed to visit it. Being it the first month of reopening, the growth is still not perceived. Therefore, the formula used is the following, with the numbers reported here affected by the due approximations:

$$\# \text{ visitors June 2020 (COVID)} = \# \text{ visitors June 2020 (no COVID)} \times \text{Participation Rate} = 7,209 \times 0,0516 = 372 \text{ visitors}$$

In which:

$$\# \text{ visitors June 2020 (no COVID)} = \# \text{ visitors June 2019} \times \text{growth trend (linear regression)}$$

And:

$$\text{Participation Rate} = \frac{\text{Actual visitors 1}^{\text{st}} \text{ week of March 2020 (COVID)}}{\text{Expected visitors 1}^{\text{st}} \text{ week of March 2020 (no COVID)}} = \frac{171}{3,313} = 5.16\%$$

After this, it is necessary to compute the visitors expected for July, which corresponds to second month after the reopening. For this scenario, the regional mobility is supposed to start at the beginning of this month, while from the second half of the month it will be also allowed to move travel in the entire country in absence of restrictions. Furthermore, it is from this month that the growth component enters in the formula, which is expressed as follows:

$$\begin{aligned}
& \# \text{ visitors July 2020 (COVID)} \\
& = \# \text{ visitors July 2020 (no COVID)} \times \text{Participation Rate} \times (1 + \text{Growth Rate}) \\
& \quad \times (1 + \text{Mobility Coeff.}_{\text{Regional}}) \times 0.5^{14} \\
& \quad + \\
& \quad \# \text{ visitors July 2020 (no COVID)} \times \text{Participation Rate} \times (1 + \text{Growth Rate}) \\
& \quad \times (1 + \text{Mobility Coeff.}_{\text{National}}) \times 0.5 \\
& = 4,282 \times 0.0516 \times (1 + 0.1) \times (1 + 0.1082) \times 0.5 + 4,282 \times 0.0516 \times (1 + 0.1) \times (1 + \\
& 0.7183) \times 0.5 = 343 \text{ visitors}
\end{aligned}$$

The Growth Rate is predetermined on the basis of the scenario under analysis, while the Mobility Coefficients are obtainable with these simple formulas, of which the required data are readable from the previously introduced Table 11:

$$\begin{aligned}
\text{Mobility Coeff.}_{\text{Regional}} &= \% \text{ visitors in the Museum Region} - \% \text{ visitors in the Museum Province} = \\
& 0.2929 - 0.1847 = 0.1082
\end{aligned}$$

$$\begin{aligned}
\text{Mobility Coeff.}_{\text{National}} &= \% \text{ of Museum national visitors} - \% \text{ visitors in the Museum Province} = 0.903 - \\
& 0.1847 = 0.7183
\end{aligned}$$

After having done this, computations must be concluded with the number of visitors as regards each other month, until the end of 2020. Starting from August, the coefficient *i* of the formula increases of one unit for each of the following months, therefore the influence of the Growth Rate on expected visitors becomes stronger as the year under consideration gets to its conclusion. For sake of completeness, the general formula applied to the month of August is reported below, while the number of expected visitors forecasted by the model over the year is reported, for each month, in Table 15.

$$\begin{aligned}
\# \text{ visitors August 2020 (COVID)} &= \# \text{ visitors August 2020 (no COVID)} \times \\
& \text{Participation Rate} \times (1 + \text{Mobility Coeff.}) \times (1 + \text{Growth Rate})^2 = 6,406 \times 0.0516 \times \\
& (1 + 0.7183) \times (1 + 0.1)^2 = 687
\end{aligned}$$

¹⁴ This coefficient is necessary since we are considering half of the month

	Jun. 2020	Jul. 2020	Aug.2020	Sep. 2020	Oct. 2020	Nov.2020	Dec. 2020
Visitors forecasted by the model	372	343	687	1,968	2,596	2,483	2,182

Table 15: Monthly visitors forecasted by the model for the scenario considered

At this point, the difference between the number of visitors forecasted through the linear regression and the visitors expected to come according to this scenario, leads to identify the loss of audience due to the COVID-19 emergency. This is easily obtainable for each month by applying the formula below, of which the results, as regards Gallerie Estensi of Modena, are readable in Figure 27.

$$\Delta \text{ visitors month}_i \text{ 2020 (COVID)} = \# \text{ visitors month}_i \text{ (no COVID)} - \# \text{ visitors month}_i \text{ (COVID)}$$

	23feb-29feb	mar-20	apr-20	mag-20	giu-20	lug-20	ago-20	set-20	ott-20	nov-20	dic-20
#visitors forecasted (no COVID)	764	12,105	14,056	9,987	7,209	4,282	6,406	16,667	19,993	17,380	13,886
Real data (no estimate)											
	23feb-29feb	mar-20	apr-20	mag-20	giu-20	lug-20	ago-20	set-20	ott-20	nov-20	dic-20
#visitors Scenario 1 July -15 July (10%)	0	171	0	0	372	343	687	1,968	2,596	2,483	2,182
	23feb-29feb	mar-20	apr-20	mag-20	giu-20	lug-20	ago-20	set-20	ott-20	nov-20	dic-20
Δ visitors (reduction) due to COVID	764	11,934	14,056	9,987	6,837	3,939	5,719	14,699	17,397	14,897	11,704

Figure 27: Loss in terms of expected visitors (for the Gallerie Estensi in the considered scenario)

Keeping the focus on the scenarios related to a Growth Rate equal to 10%, for sake of completeness are hereby presented also the results obtained by the application of these formulas to the other 8 scenarios obtained by combining the regional reopening timing with the date in which national mobility will be allowed as well. For what concerns the Gallerie Estensi of Modena, these numbers can be read in the following Figure 26. Moreover, in order to provide the reader with a larger span of observation, also the results regarding the other two collaborating cultural institutions have been reported. Indeed, the numbers as regards the Musei Reali of Turin are observable in the graph contained in Figure 28, which have been duplicated and adjusted below for the Palazzo Ducale of Mantua (Figure 29).

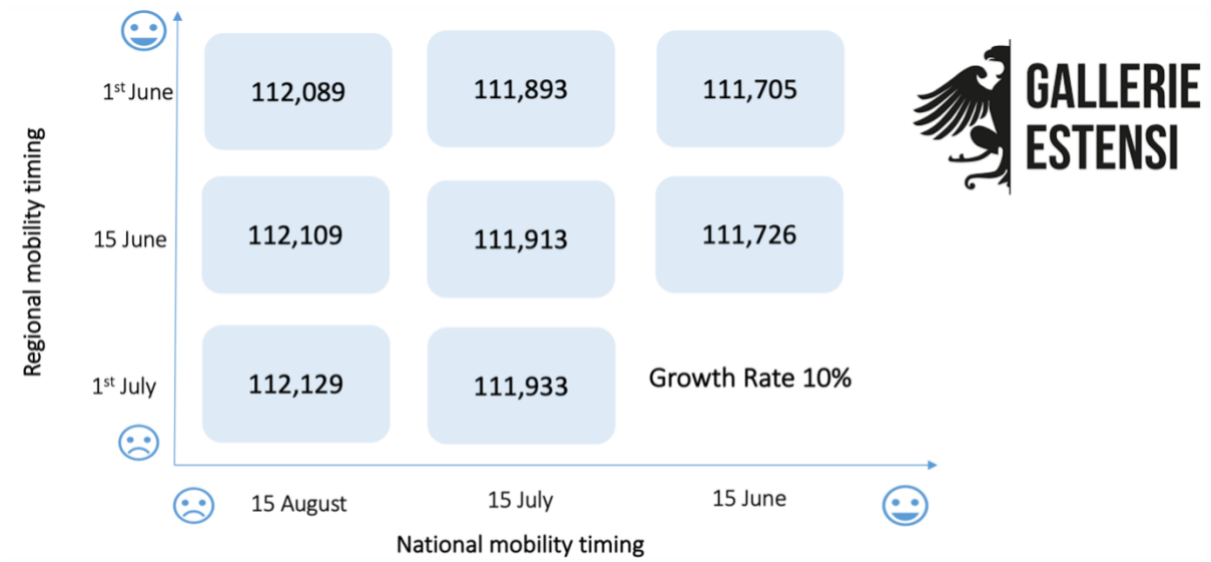


Figure 28: Forecasted loss of visitors for 2020 (Gallerie Estensi of Modena)

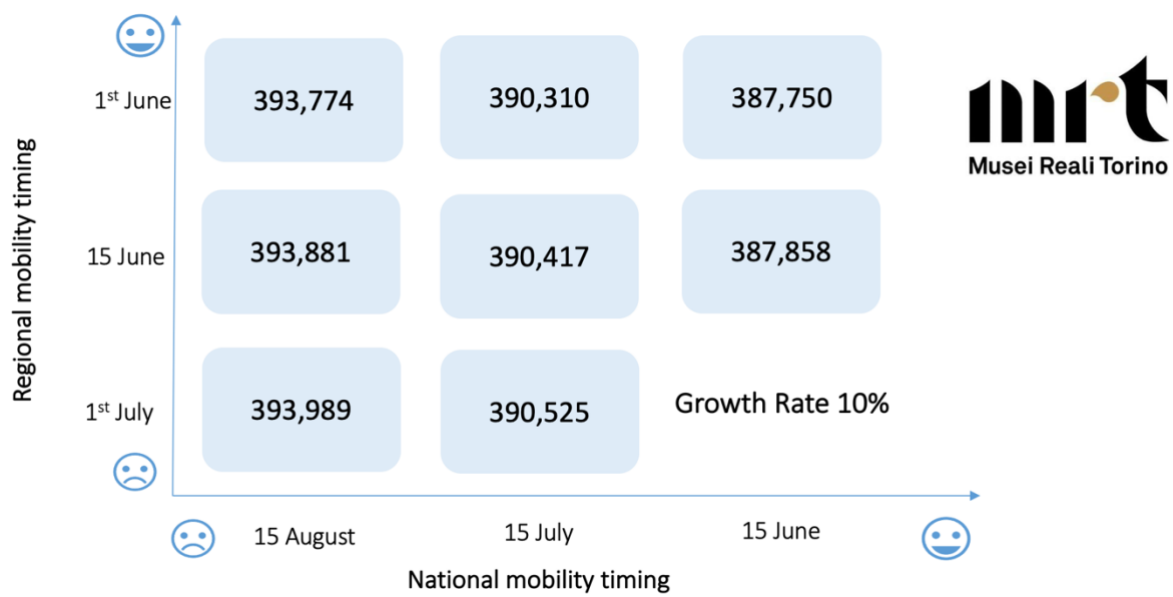


Figure 29: Forecasted loss of visitors for 2020 (Musei Reali of Turin)

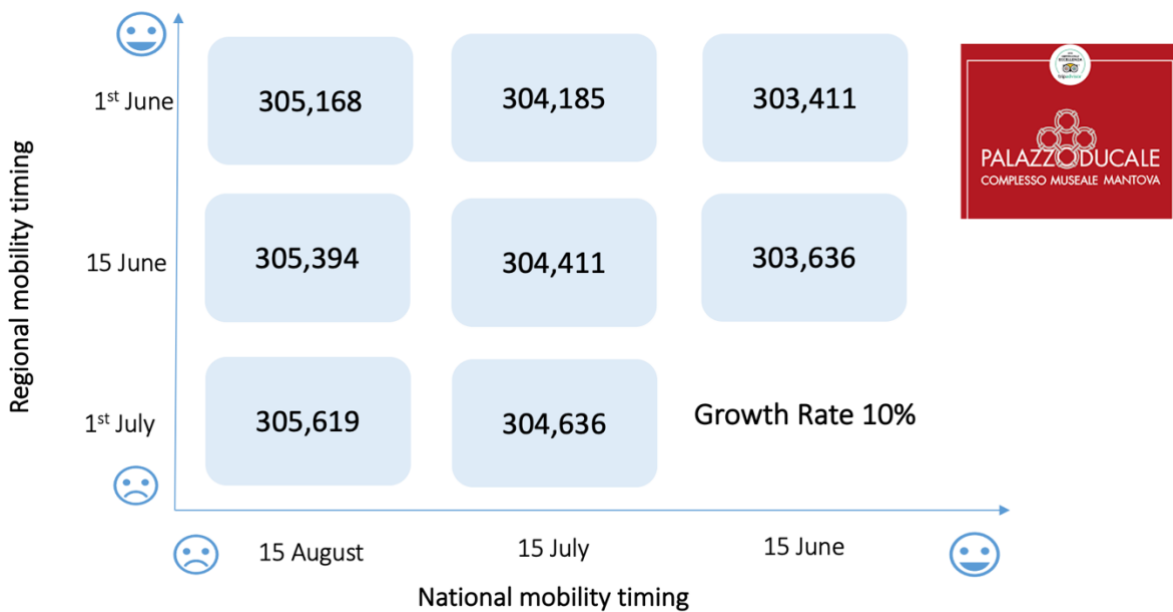


Figure 30: Forecasted loss of visitors for 2020 (Palazzo Ducale of Mantua)

In order to obtain the economic assessment of how this loss in terms of audience will impact on cultural institutions, it is necessary to transform these numbers from visitors into monetary terms. To this extent, the Monthly Revenue per Visitor Coefficient (previously introduced in Paragraph 3.2) has been used, of which it is possible to recall the formula as:

$$\text{Monthly Revenue per Visitor Coefficient}_i = \frac{\text{Revenues from entry tickets}_i}{\text{Number of visitors}_i}$$

In which the index *i* represents the single month. The numbers contained in Table 16 below refers to the ones already introduced in Paragraph 3.2, with the clarification that, as regards February, the economic losses are computed using a coefficient specific for the last week loss of this month, being museums regularly open during the first three weeks.

Month	Revenues	Number of visitors	Coefficient
Jan. 2019	€ 11,608.90	5,667	2.05
Feb. 2019	€ 7,518.50	5,657	1.33
Last week of Feb. 2019	€ 1,536.00	739	2.08
Mar. 2019	€ 12,906.90	11,709	1.10
Apr. 2019	€ 32,529.20	13,596	2.39
May 2019	€ 21,715.40	9,660	2.25
Jun. 2019	€ 27,983.60	6,973	4.01
Jul. 2019	€ 11,905.50	4,142	2.87
Aug. 2019	€ 18,365.10	6,196	2.96
Sep. 2019	€ 19,255.30	16,121	1.19
Oct. 2019	€ 18,376.80	19,338	0.95
Nov. 2019	€ 17,035.60	16,811	1.01
Dec. 2019	€ 10,107.10	13,431	0.75

Table 16: Revenue per visitor for Gallerie Estensi of Modena

These numbers have been obtained by elaborating the data of the Gallerie Estensi of Modena, it is possible to consult the values regarding the other two requiring institutions in the Appendix. Having said this, Figure 31 explains the transformation from missed entry ticket into cash losses, always taking into consideration the Emilian museum. On the entire year, this missed amount is obtainable by applying the following summatory:

$$\text{Yearly economic loss}_i = \sum \Delta \text{ visitors due to COVID}_i \times \text{Monthly Revenue per Visitor Coefficient}_i$$

As always, in this formula the index i refers to the specific month and, for each institution, the amount of money earned gained in the first week of March, in which the institutions were open although the lockdown was about to begin, has been excluded from this summatory (for the Gallerie Estensi of Modena this amount of money was equal to 322.40 €).

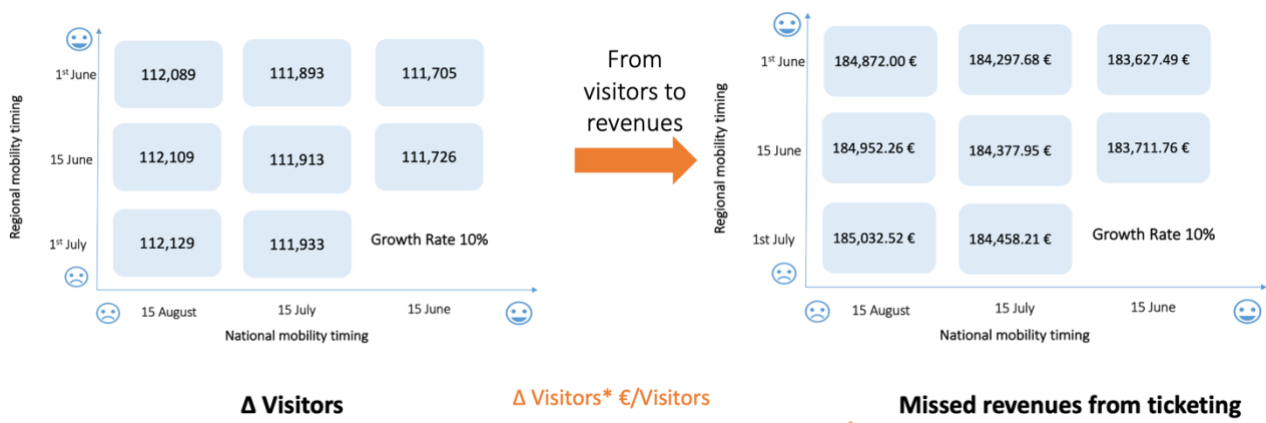


Figure 31: Economic impact of the COVID-19 pandemic for the Gallerie Estensi of Modena

In continuity with what done for the impact in terms of visitors, the results in terms of economic loss due to missed ticketing are reported for the Musei Reali of Turin (Figure 32) and for the Palazzo Ducale of Mantua (Figure 33) as well.

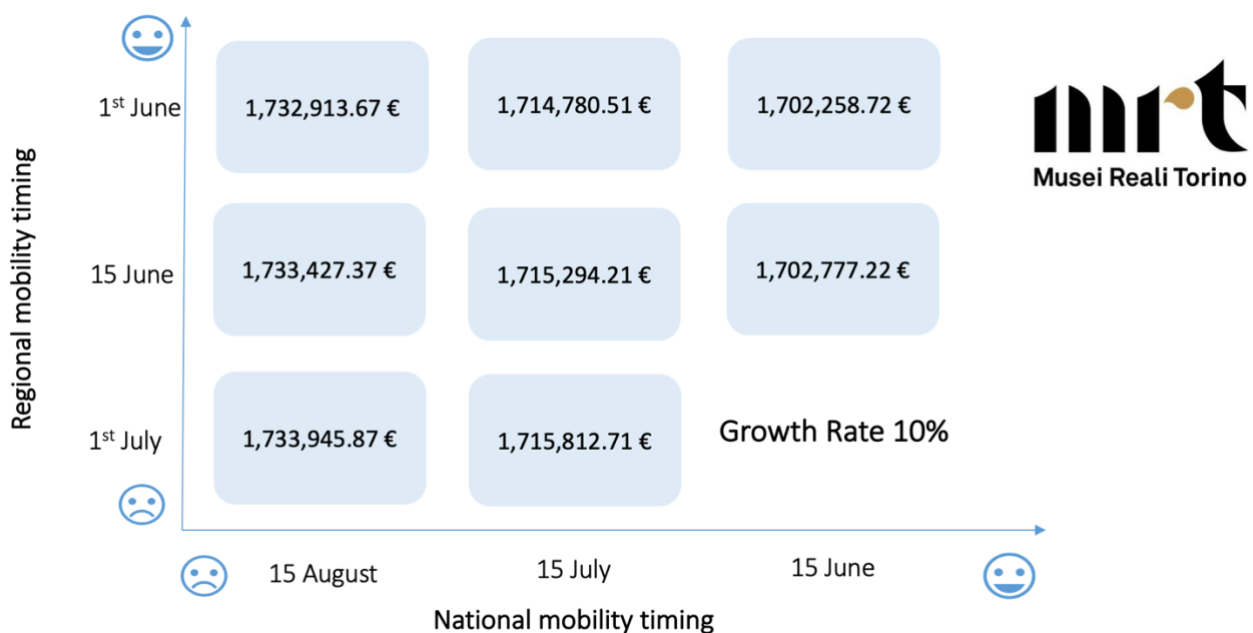


Figure 32: Economic impact of the COVID-19 pandemic for the Musei Reali of Turin

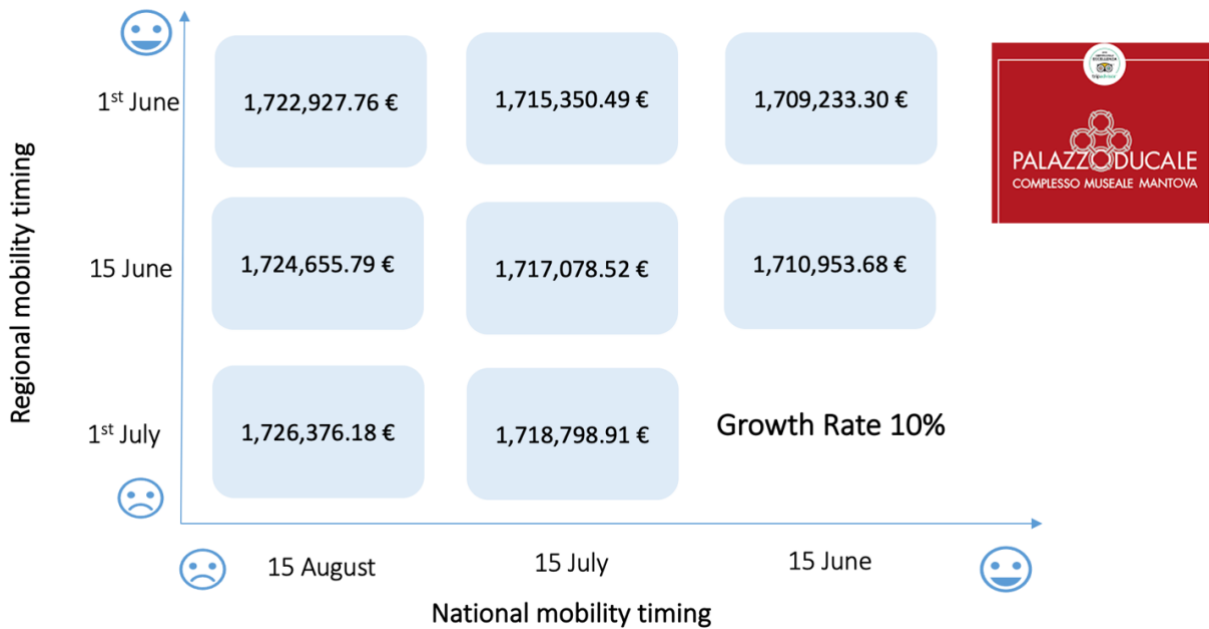


Figure 33: Economic impact of the COVID-19 pandemic for the Palazzo Ducale of Mantua

4.3 Model generalization

This Paragraph is thought to conclude the Chapter regarding the pure presentation of the developed model, proposing a generalization of this tool. Indeed, as stated in the introduction, the final goal is to help the cultural heritage sector in assessing the impact that the pandemic outbreak might bring, therefore this tool cannot be limited to an application only to the three mentioned northern Italian museums. However, it is necessary to notice how the formulation of this Master Thesis is, to certain extents, diverse to the traditional formulation of scientific papers. As mentioned by Hall (1994), usually these publications have a clear structure, in which the presentation and discussion of results come after the phase in which the methods and models are introduced. In this Master Thesis, it might appear to the reader that the modelling process and application phase are somehow mixed, being the formulas and the assumptions behind the model presented together with the direct application on the three requiring cultural institutions. This alternative approach does not have to be interpreted as erroneous but, contrariwise, the choice of presenting the Multiple Scenarios Model in this way to the reader has been driven to the particular conditions in which the working group has operated and with which this model has to do. The uncertainty of the external environment, the rapid changes that norms have undergone in the arch of few days but also the possibility of interacting with practitioners of the Italian cultural system and to have direct access to relevant data, led the working group to adopt a practical approach which offered the possibility of testing hypothesis rapidly and, at the same time, building the theoretical foundations over which the model is based.

Having made this clear, it is possible to move to the actual aim of this Paragraph and to present a generalization of the Multiple Scenarios Model. Since its conception, this tool has always been

imagined to be flexible, and not just a single application derived from the particular situations of the three northern Italian museums who collaborated to the research project. The Paragraph is therefore divided in two Sections, in which the dimensions that constitute model are discussed in general terms extrapolating them from an Italian-specific context. These correspond with the different levels of territorial mobility allowed on the one hand, and with the rhythm of growth as regards visitors on the other. Thus, this creates a generalized version of the model which can then be applied to other realities of the cultural heritage sector, in the ambit of the response to the pandemic emergency.

4.3.1 Mobility

This dimension is represented in the model with the Cartesian plane and it is fundamental, since it allows to generate scenarios which are progressively increasing the span of allowed mobility after a period characterized by strong limitations like a generalized lockdown. It is clear that, being the model developed on the basis of the Italian context, the application to another museum suits better if this institution is located in Italy. Indeed, the three levels of administrative division (Province, Region and Nation) can be exploited in this case, and the formulas to be used are the same presented in Section 4.2.1. Regardless the growth of visitors, which will be discussed in the next Section, the component determined by the mobility permitted leads to this previously presented formula:

$$\# \text{ visitors month}_i \text{ 2020 (COVID)} = \# \text{ visitors month}_i \text{ (no COVID)} \times \text{Participation Rate} \times (1 + \text{Mobility Coeff.})$$

The model can be even made more complex and accurate, by adding ulterior dimensions concerning mobility which, consequently, will necessitate of further expansions of the Mobility Coefficient. In the application presented, to the three levels of mobility correspond two values of this coefficient. The first one marks the expansion of potential audience when the possibility of moving in the entire Region of residence is permitted:

$$\text{Mobility Coeff.}_{\text{Regional}} = \% \text{ visitors in the Museum Region} - \% \text{ visitors in the Museum Province}$$

The successive level, instead, measures the delta which occurs when the possibility of free movement within the national territory is given:

$$\text{Mobility Coeff.}_{\text{National}} = \% \text{ of Museum national visitors} - \% \text{ visitors in the Museum Province}$$

However, this model does not want to be limited to the Italian scenario and it is possible to exploit its formulas also for applications regarding other countries. In general terms, an administrative subdivision is a defined part of the territory of a state, within the boundaries of which the competence of an administrative body is limited. In almost all states, the territory is divided into several districts (whose name can vary significantly from country to country) and there are often multiple levels of subdivision. In particular, there may be:

- *A basic level:* corresponding with small territorial districts, mostly referred to as municipalities in which, however, there are legal systems that can provide for further subdivisions, such as fractions or districts. Italy is a clear example of this type of systems;
- *One or more upper levels:* with variously named constituencies (e.g. state, region, province, department, prefecture, district, canton, county, district, voivodship, governorate) which group together several constituencies of the immediately lower level.

Some of the aforementioned administrative subdivisions are of a general nature, in the sense that they are used to delimit the competence of a plurality of bodies. Others, however, are specific to certain organs. There may also be distinct subdivisions for administrative and judicial authorities. In general subdivisions there may be a central government representative, such as a prefect or governor. Furthermore, there can be a territorial body, that is a public body for which the territory is not only the limit of its competence (as happens for other local entities) but also a constituent element of the body itself, whose internal governing bodies are representative of the resident population (in Italy there are Regions, Provinces and Municipalities of this type). Through these organs the self-government of the community residing in the district is realized, according to various degrees of autonomy that reaches the maximum in federal systems (M.G. Melchionni, 1950).

For the scope of this Master Thesis, it is important to mention this, since it is a prove that the hierarchical Italian administrative structure, whose boundaries have been used as a proxy of the increase in potential public that an incremental release of the containment measures might bring, can be adopted for modelling this concept for museums located in other countries. As an example, it is here reported the case of France, another European nation which have been strongly affected by the COVID-19 pandemic as well, counting almost 2 million registered cases as of November 2020 (WHO). As of 2016, the territory of France (Figure 34) is divided into 18 Regions (13 of which refer to continental France), 102 departments and 36,658 municipalities; for statistical purposes also the Arrondissement and Cantons are considered (REGI¹⁵, 2018).

¹⁵ REGI represents the European Parliament Committee on Regional Development

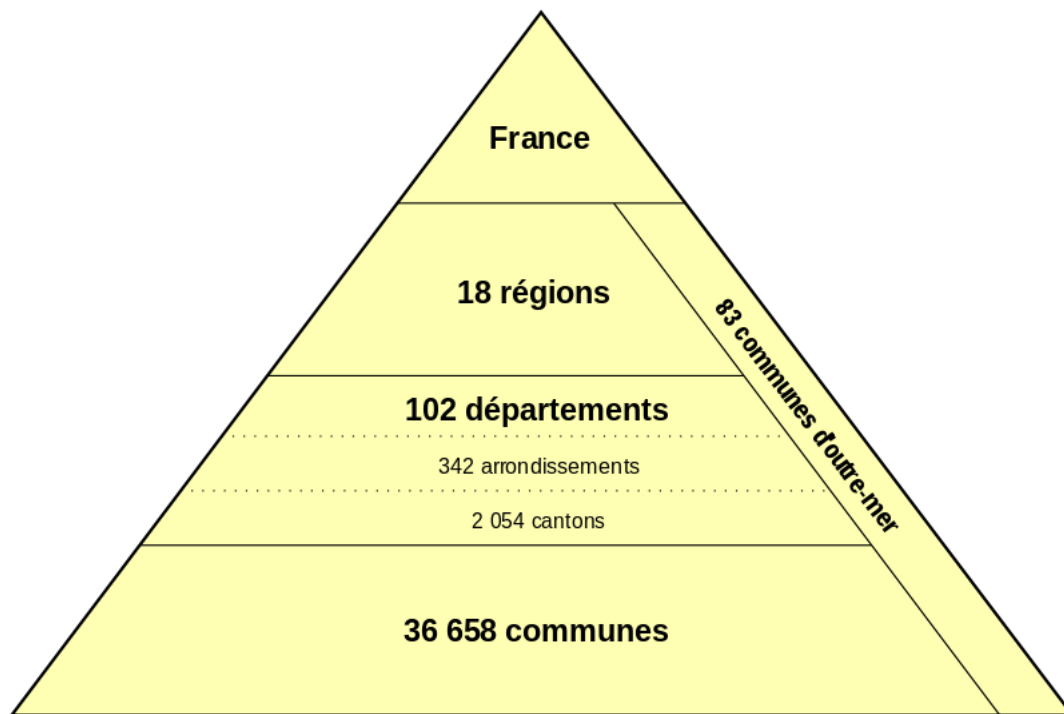


Figure 34: Administrative subdivision of France as of 2016

Therefore, in the hypothetical application of this model to a French cultural institution, these readily available borders will be surely exploited. Maintaining a three levels division as regards the evolution of permitted mobility it is possible to generalize the formulas as follows:

$$\text{Mobility Coeff.}_{\text{Level 2}} = \% \text{ Museum visitors at Level 2} - \% \text{ Museum visitors at Level 1}$$

$$\text{Mobility Coeff.}_{\text{Level 3}} = \% \text{ Museum visitors at Level 3} - \% \text{ Museum visitors at Level 1}$$

Keeping into consideration the French example, Level 1 can be represented by the Departments (in the Italian application it referred to Province), while Level 2 can be extended to the Regions. The last Level, off course, always indicates the national base of potential visitors.

Concluding this Section, it is also necessary to mention that the formula also has a component regarding on the monthly visitors estimated in a hypothetical absence of the COVID-19 pandemic. In the cases presented, the forecasts have been computed by means of a linear regression using the museums historical data. This way of proceeding can be considered as a reference for the model, even though, it does not want to be a constraint when applying this tool to other realities. The working group agreed that this model needs to have a certain degree of freedom for its application. Therefore, a cultural institution willing to adopt this framework for assessing the economic impact of the pandemic, does not have to be forced to adopt the same technique presented in this Master Thesis. The personnel responsible of an eventual assessment in terms of public loss, must be free to adopt the forecasting technique to which they are more familiar with and this will not represent a significant change in the functioning of the model.

4.3.2 Growth of visitors

In order to conclude the discussion about the model generalization, it is also necessary to consider the component of the formula which gives the measures about the monthly growth of the percentage of visitors (over the total number of potential visitors). The formula has been firstly introduced in Section 4.2.1 and it has also been reported below:

$$\# \text{ visitors month}_i \text{ 2020 (COVID)} = \# \text{ visitors month}_i \text{ (no COVID)} \times \text{Participation Rate} \times (1 + \text{Mobility Coeff.}) \times (1 + \text{Growth Rate})^i$$

Regardless the forecasted number of visitors for the specific month and the influence of permitted mobility, which have been treated in the previous Section, the component regarding the growth of visitors can be expressed in general terms as an exponential function of time, in which the base (a) is constant and higher than 1, with an exponent that increases according to the passing of months:

$$\text{Visitors Growth} = f(t) = a^t = (1 + \text{Growth Rate})^t$$

The choice of adopting such function of growth as regards visitors, derives from the aim to maintain the continuity as regards the trend of increase in terms visitors for Italian museums, presented in Chapter 1. Together with this aspect, the possibility that current digital technologies provide to cultural institutions have also been mentioned by scholars of the field. Particularly, as regards the possibilities that these provide to cultural institutions in terms of marketing and visit experience (A. Palombini, 2012). Moreover, the growth becomes more relevant as the end of the year gets close, meaning that a likely gradual return to normality might bring a positive effect on museums ticketing. The Growth Rate represents therefore the other dimension that, if crossed with the timing of reopening, generates the possible scenarios useful for performing the assessment of the pandemic economic impact over culture. In the presented analysis, it has been chosen to assume three fixed values for the Growth Rate, generating a total of 24 scenarios. Again, this choice does not influence the assumptions over which the model is built, but it is a way through which it is possible to increase the precision of the model and, therefore, the complexity of the scenarios, with a consequent increase in the amount of calculations as well. The formula presented in this Chapter represents the standard adopted by the working group who developed the instrument but, again, it does not want to be a constraint for further studies and applications. Furthermore, being this factor strongly affected by the

perception of the potential audience, a discussion about its measurement and what could have been done better in this research is presented to the reader in the last Chapter of this Master Thesis.

Beside the Growth Rate of visitors, another component influencing the dimension of the possible audience is given by the Participation Rate. This number represents a base over which the computations shall start and, probably, it is the factor which is mostly dependent on the specific situation of the single cultural institution. In the ambit of the presented study, this number has been computed as the ratio between the number of visitors registered in the first week of March 2020 (in which the pandemic was already begun) and the forecast regarding the same period in absence of the health emergency:

$$Participation\ Rate = \frac{Actual\ visitors\ 1^{st}\ week\ of\ March\ 2020\ (COVID)}{Expected\ visitors\ 1^{st}\ week\ of\ March\ 2020\ (no\ COVID)}$$

This choice has been driven by the availability of data at that time, yet this way of calculating cannot be assumed to be adapted to a wider group of cultural institutions. This number represents a constant in the model and, as said for the Growth Rate of visitors, it is affected by the perception and subjectivity of potential audience and of the respective cultural institution as well. In order to generalize this concept, it is here proposed an alternative version of the formula:

$$Participation\ Rate = \frac{Actual\ visitors\ period\ x\ (COVID)}{Expected\ visitors\ period\ x\ (no\ COVID)}$$

Indeed, although this does not aim to be dogmatic, what is possible to suggest when applying this tool to other cultural realities, is to consider a period of the pandemic in which the institution was open to the public and, having clear the forecast method to be used, rapport this value to the number of visitors that should have been registered in the same period of the year, in absence of the COVID-19 pandemic outbreak. Even this component will be treated in the aforementioned dedicated Paragraph at the end of this Master Thesis work.

5. Results presentation

This Chapter, although mainly dedicated to the presentation of the results achieved by the museums who participated at this research project, actually possess multiple goals and it has been articulated following a particular scheme. At first, a Paragraph dedicated to the pandemic trend during the reopening phase in Italy is presented. This can be considered as an extension of what reported in the literature review under the Section 2.3.2, and it has been inserted to provide the reader with a general picture of the Italian context after the first wave of COVID-19 pandemic. Then, the operative results in terms of visitors and revenues from visits, as regards the requiring institutions, has been considered, in order to assess which of the scenario has occurred for each institution and to test the goodness of the model in assessing the economic impact that the health emergency brought to cultural institutions, which represents the main objective of this Master Thesis. This analysis considers the period comprised between the months of June and October of 2020, in Italy. Indeed, as in many other countries worldwide, it is at the end of this month that a second wave of the pandemic occurred and led governments to retake in place containment measures in order to safeguard the health of their citizens. In relation to this, the Chapter also contains a Paragraph dedicated to the second coming of the health emergency. In addition to the description of the boundary conditions which, again, disrupted the environment in which the entire cultural sector operates, the final Paragraph is also used in order to explain why, considering the Multiple Scenarios Model an instrument subjected to improvements and a starting point for future research, the working group retains this analysis concluded, with the developed model suitable for further applications.

5.1 The situation after the reopening in Italy

In this Paragraph it is also recalled what already described in Chapter 2, particularly under the Section 2.3.2, as regards the evolution of the COVID-19 pandemic in Italy. That Section ended mentioning Prime Ministerial Decree published on June 11, aimed to reduce the containment measures. In addition to the previously permitted reopening concerning museums, schools, restaurant businesses, gyms, hairdressers and beauty centres, arcades and betting halls. Shows open to the public were permitted in theatres, cinemas and concert halls, if observing the procedures of social distancing. The bathing establishments, wellness centres, cultural and social centres were reopened, even though the conduction of events was allowed only in static form.

Moving forward in the timeline, this Paragraph wants to describe the events occurred previous to the second wave of COVID-19 pandemic, which led to further limitations undertaken by the government

in order to stop the curve of contagions. The first event to report dates July 9, 2020, in which an order signed by the Minister of Health Roberto Speranza blocked entry and transit from 13 countries considered at risk, with the suspension of the related direct and indirect flights. These countries were respectively: Armenia, Bahrain, Bangladesh, Brazil, Bosnia Herzegovina, Chile, Kuwait, North Macedonia, Moldova, Oman, Panama, Peru, Dominican Republic. To which, on July 16, Serbia, Montenegro and Kosovo were added to the list, and on 21 September France as well.

Due to the increase in infections in Italy, on August 16 an ordinance of the Minister of Health was signed which orders, starting from the following day and until September 7, the closure of discos and dance halls, and which makes the use of masks mandatory from 6.00 p.m. to 6.00 a.m. (even in public spaces).

On September 6, 2020, a new Prime Ministerial Decree was signed, in force from the following day until September 30, extending the previous containment measures, but allowing the entry into the national territory to those who, coming from outside the Schengen area, they must reunite with a person with whom they have *"a stable emotional relationship, even if not cohabiting"*.

As regards the app Immuni, on 2 October 2020, the Italian government started an awareness campaign to promote the diffusion of the application. To this, all Italian journals, public and private, provided their support. The application, which on 1 October 2020 had 6,679,118 downloads, reached an increase to 8,316,353 on 10 October (24.5% more) and a national average coverage of 15.7% (ANSA¹⁶, 2020).

These represent the major facts that characterized the so-called "Phase 3" of reopening as regards the Italian context. In these months cultural institutions were opened to the public and able to operate again, in respect of the health measures imposed by law. From this Paragraph, which is however a synthetic representation of the events occurred between the summer and the autumn of this particular year, it is evincible how the health emergency was far from being defeated and several inconsistencies and issues still persisted, despite the reopening maneuvers made by the government. These months have been the antechamber of the second wave of this pandemic, exploded from October 2020, which will be however discussed with more detail in Paragraph 5.3, that is preceded by the following 5.2. In the next Paragraph the focus is moved to two of the collaborating institutions and their respective operative results will be showed to the reader, confronting them with respect to the parameters individuated by the model.

¹⁶ Agenzia Nazionale Stampa Associata

5.2 Collaborating institutions results

This Paragraph is intended to provide the results both in terms of number of visitors and relative revenues from tickets that, the collaborating institutions, registered in the months following the progressive reopening, after the first wave of the COVID-19 pandemic. Before proceeding with the description, it is necessary to make a due clarification. Indeed, unfortunately, due to complications arose consequently the health emergency and to issues related to the management of the museums itself (one above all the nomination of the new Director), the Palazzo Ducale of Mantua has been unable to follow the second part of this research project, and not even to collaborate with the working group and the other two requiring institutions for the monitoring of the context verified after the general lockdown. Therefore, this Paragraph is divided in three Sections, starting with one in which the criteria for this analysis are explained to the reader. The following two, instead, are dedicated to the remaining cultural institutions: the first to the Gallerie Estensi of Modena, while the latter to the Musei Reali of Turin. The aim of these is to disclose and analyze the numbers gathered on the field by the museums, providing, at the same time, a comparison with the values obtained from the application of the Multiple Scenarios Model (according to the presented boundaries of analysis), which refer to the computations and the generalization presented in Chapter 4.

5.2.1 Criteria of analysis

This Section has the goal of describing the procedure through which the analysis, between the forecast of the model and the results achieved in the reality, has been carried out. The main points touched are synthesized in the following list, with the purpose of keeping this process as clear as possible for the reader.

- *Parameters used for each institution and how data have been gathered:* the analysis which has been conducted is coherent with the parameters that the Multiple Scenarios Model aims to foresee. It has been the collaborating museums themselves which, according to the directives provided by the working group, communicated the required data for monitoring. However, it is necessary to say that due to the second wave of the COVID-19 pandemic and the consequent restrictive measures described in Paragraph 5.3, this analysis stops to the end of October 2020. Therefore, formulas required to be adapted to the particular situation that the context brought. The parameters used for each institution consist in the monthly number of visitors registered from June 2020 to October 2020, and the relative amount of revenues cashed from ticketing.

- *Definition of a range of forecast:* with the purpose of building an interval for assessing the goodness of the forecast computed, the calculations already presented in Chapter 4 must be adapted for the following analysis. The formulas used for the computations remain the same, as regards the loss in terms of visitors due to the health emergency:

$$\Delta \text{ visitors month}_i \text{ 2020 (COVID)} = \# \text{ visitors month}_i \text{ (no COVID)} - \# \text{ visitors month}_i \text{ (COVID)}$$

Moreover, being the reopening of museums coincident with the possibility of interregional mobility at the beginning of June 2020, further computations would have been necessary. As a matter of fact, the actual reality appeared to be near to the optimistic scenario in which the regional and the interregional travels are allowed as of June 1 and June 15 respectively. With this information, the numbers corresponding to this new scenario, for each of the three values of Growth Rate, could have been computed. However, being these quite close to the ones already available from the mentioned scenario, the working group choose not to add further complexity to the calculations, considering this a way of testing the validity of the model a priori. This led to the identification of a range for testing the goodness of the model forecasts made by an upper bound, which corresponds to the loss of visitors in the mentioned scenario (regional reopening from June 1 and national reopening on June 15) with a Growth Rate equal to 5%, and a lower bound coinciding with the same timing as regards mobility, but with the highest value of Growth Rate (20%). Basically, these values correspond to 2 out of the 24 scenarios identified by the model under analysis.

$$\Delta \text{ visitors forecasted 2020}_{20\%} \leq \Delta \text{ visitors occurred} \leq \Delta \text{ visitors forecasted 2020}_{5\%}$$

Concluding this point, it is also necessary to precise how the actual loss in terms of visitors occurred has been computed. By exploiting the numbers provided by the collaborating institutions, it is possible to proceed by subtracting these to the forecast computed by means of the linear regression obtaining the following difference:

$$\Delta \text{ visitors month}_i \text{ 2020 (COVID)} = \# \text{ visitors month}_i \text{ (no COVID, forecasted)} - \# \text{ visitors month}_i \text{ (COVID, occurred)}$$

The total delta registered is given by the following summatory, from June to October 2020 in the particular case of this analysis:

$$\Delta \text{ visitors occurred} = \sum \Delta \text{ visitors due to COVID month}_i$$

- *Transformation from visitors to revenue loss*: in the same way in which the losses in terms of expected visitors have been treated, being the principal scope of this Master Thesis the assessment of the economic loss that the cultural sector will face due to the COVID-19 pandemic, it is necessary to translate the missed entries into economic terms. The formula is the same that has been presented previously in Chapter 4, with the clarification that the interval above which calculations have been made goes from June to October 2020:

$$\text{Yearly economic loss}_i = \sum \Delta \text{ visitors due to COVID}_i \times \text{Monthly Revenue per Visitor Coefficient}_i$$

Even in this case, a range for testing the goodness of the model forecasts has been built. The upper bound, which corresponds to the loss of visitors that may occur in the reference scenario with a Growth Rate at 5%, while the lower bound coincides with the same mobility dates and a Growth Rate equal to 20%. Again, this way of proceeding considers 2 values out of the 24 total scenarios provided by the model.

$$\text{Economic loss forecasted 2020}_{20\%} \leq \text{Actual economic loss} \leq \text{Economic loss forecasted 2020}_{5\%}$$

At the end, being the actual revenues per month made available by the collaborating museums, the actual economic loss has been computed with the following difference:

$$\text{Economic loss month}_i (\text{COVID}) = \text{Revenues month}_i (\text{no COVID, forecasted}) - \text{Actual revenues month}_i (\text{COVID, occurred})$$

Which, on a yearly base, leads to the following computation:

$$\text{Yearly economic loss}_i = \sum \text{Economic loss month}_i (2020)$$

This, off course, keeping into consideration the fact that the analysis carried out and presented in the next Sections, for both the cultural institutions that participated to the research project, has been made over the interval from June to October 2020.

5.2.2 The results of the Gallerie Estensi of Modena

In order to be as clear as possible in the presentation of results, the graphs below contain the new calculations for each of the 24 scenarios generated by the model. These differ from those presented in Chapter 4, because they stop at the month of October 2020, which is the end of this period of analysis and also the last month in which cultural institutions were open to the public in Italy. In particular, Figure 35 contains the calculations related to scenarios with a Growth Rate equal to 5%.

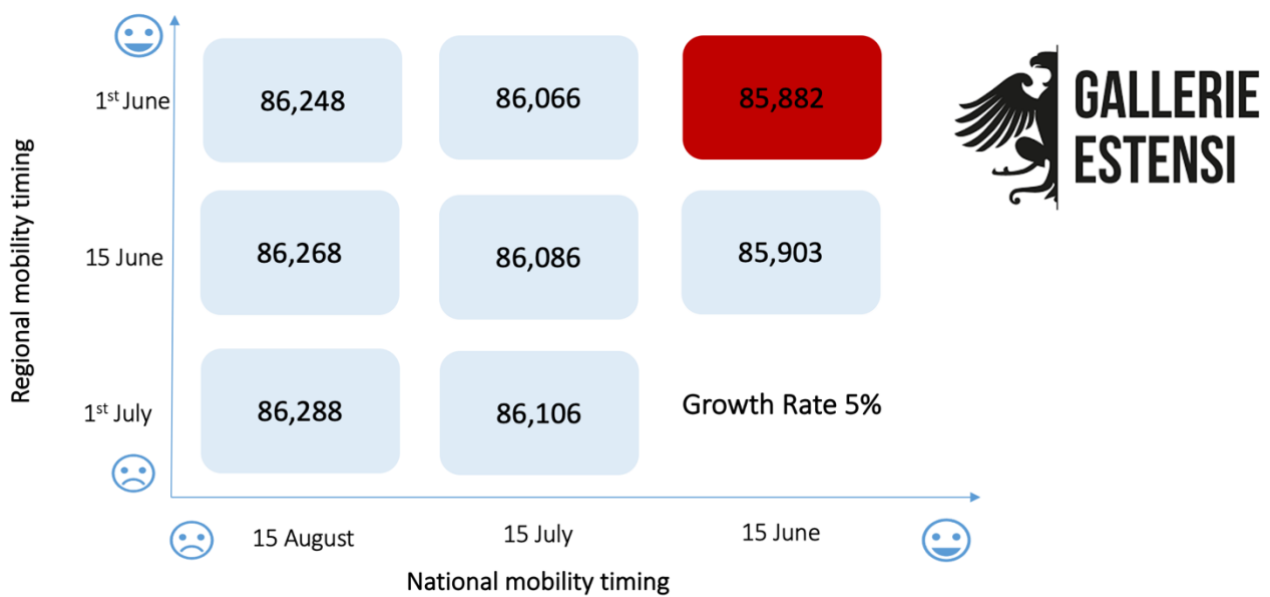


Figure 35: Loss in terms of visitors for the Gallerie Estensi of Modena (from June to October, Growth Rate 5%)

This graph recalls the ones presented in Chapter 4, but it excludes from the interval of forecast the months of November and December 2020, as stated by the formulas presented by the previous Paragraph 5.2.1. The block marked in red coincides with the upper bound of the range considered for the analysis, it is indeed the highest possible forecasted loss, in a scenario in which the regional mobility is allowed from June 1, 2020, while the possibility of free movement across the whole national territory is given from June 15. This scenario concerning mobility has been chosen since it is the closer one to the facts that actually happened in Italy after the first generalized lockdown and, therefore, the assessment is made with this block as a reference. In Figure 36 below, the same computations are presented, but with the parameter of the Growth Rate taken equal to 10%.

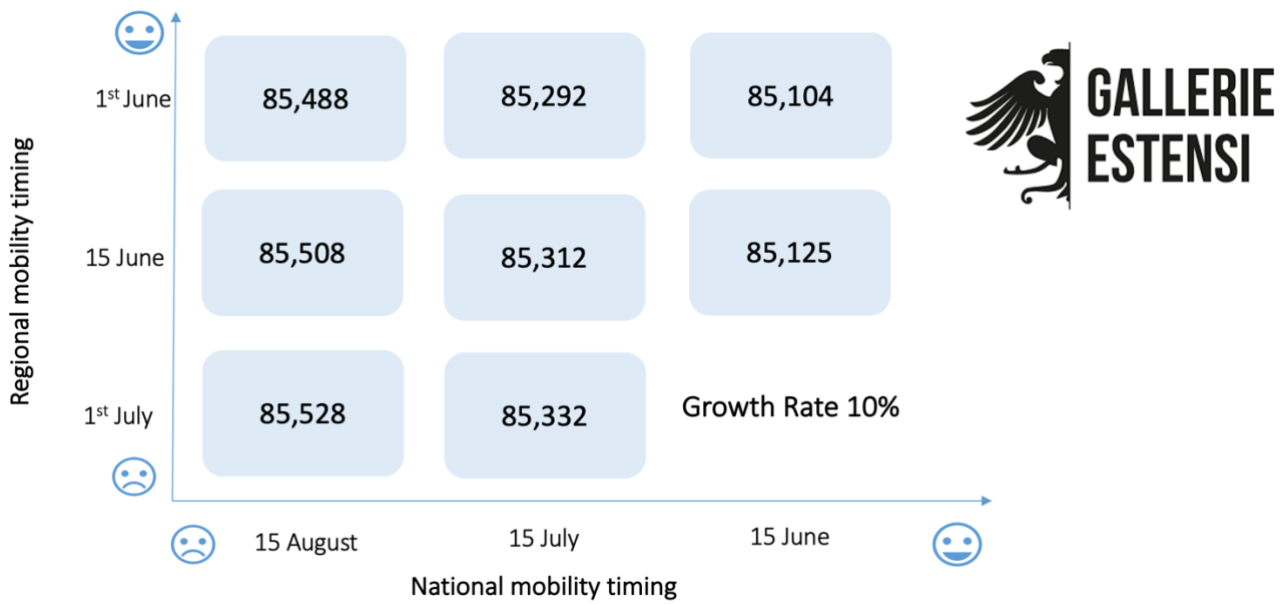


Figure 36: Loss in terms of visitors for the Gallerie Estensi of Modena (from June to October, Growth Rate 10%)

Proceeding in this direction, also the calculations of the scenarios referring to a Growth Rate equal to 20% have been reported (Figure 37). Precisely, the green block contained in the graph below represents the lower bound for the analysis range, corresponding to the lowest possible forecasted loss in terms of visitors.

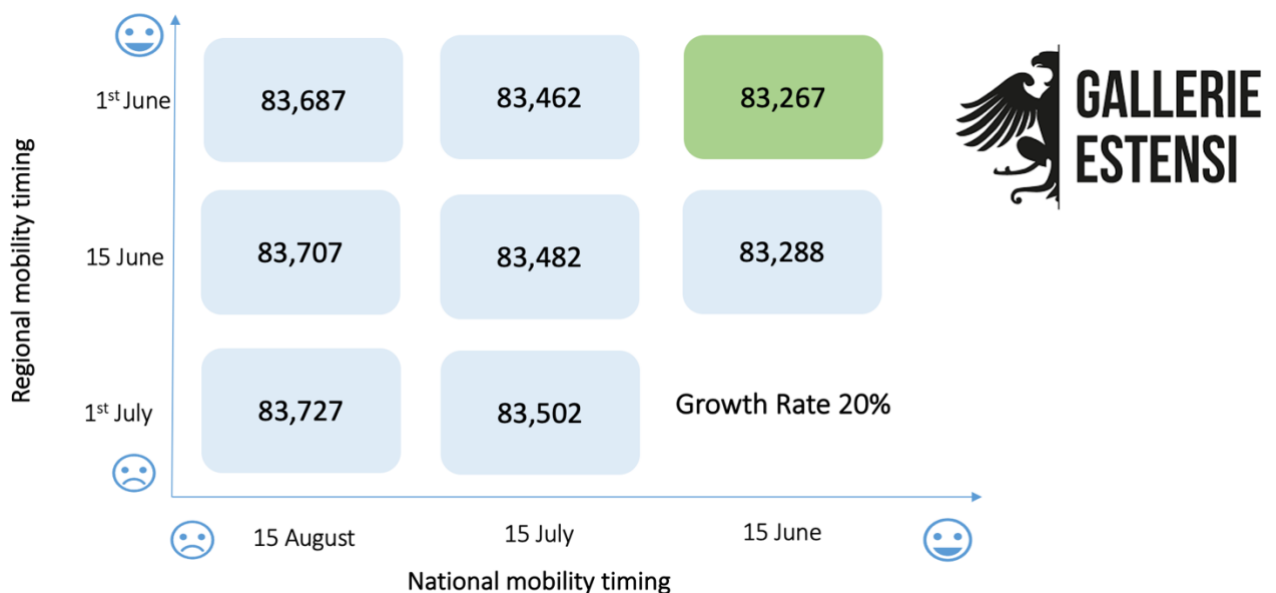


Figure 37: Loss in terms of visitors for the Gallerie Estensi of Modena (from June to October, Growth Rate 20%)

With the same logic showed in Chapter 4, it is necessary to determine the economic impact deriving from these losses of attended audience. The graphs below contain the transformation of the numbers of missed entries into monetary terms. The first one, in Figure 38, refers to the scenarios obtained with a Growth Rate considered equal to 5%.

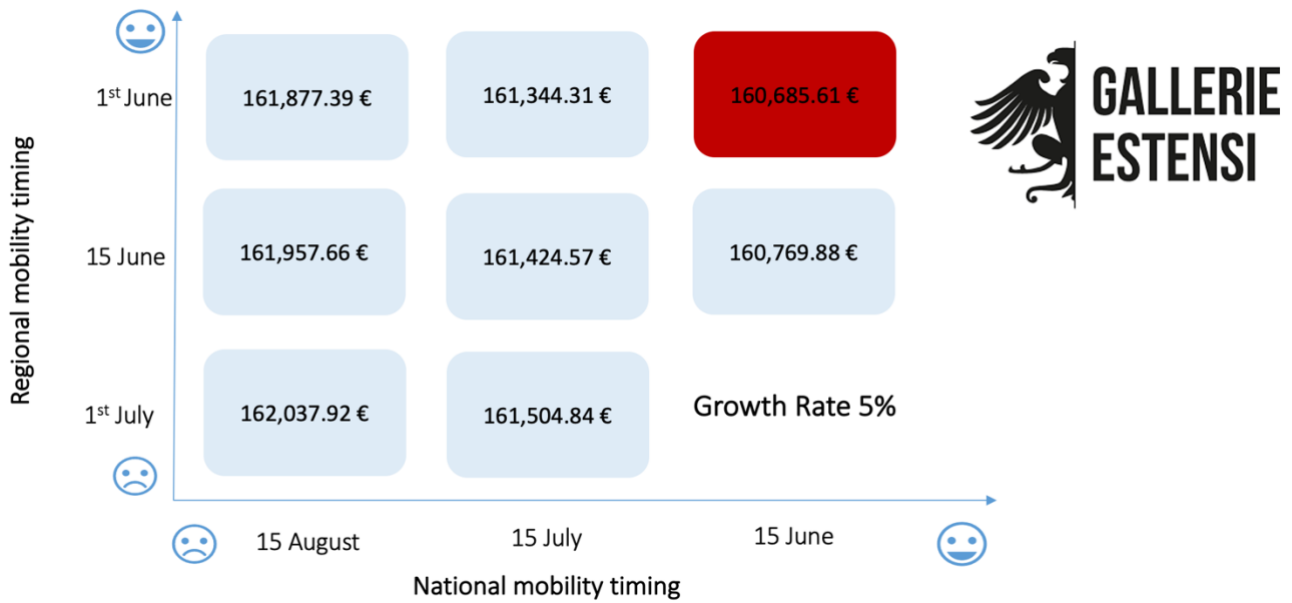


Figure 38: Economic loss for the Gallerie Estensi of Modena (from June to October, Growth Rate 5%)

Again, the red block represents the upper bound for the range of analysis, coinciding with the highest possible loss forecasted, in case of a regional reopening scheduled on June 1, 2020 and the possibility of national mobility starting from June 15. Moving forward, Figure 39 contains the calculations obtained with Growth Rate equal to 10%.

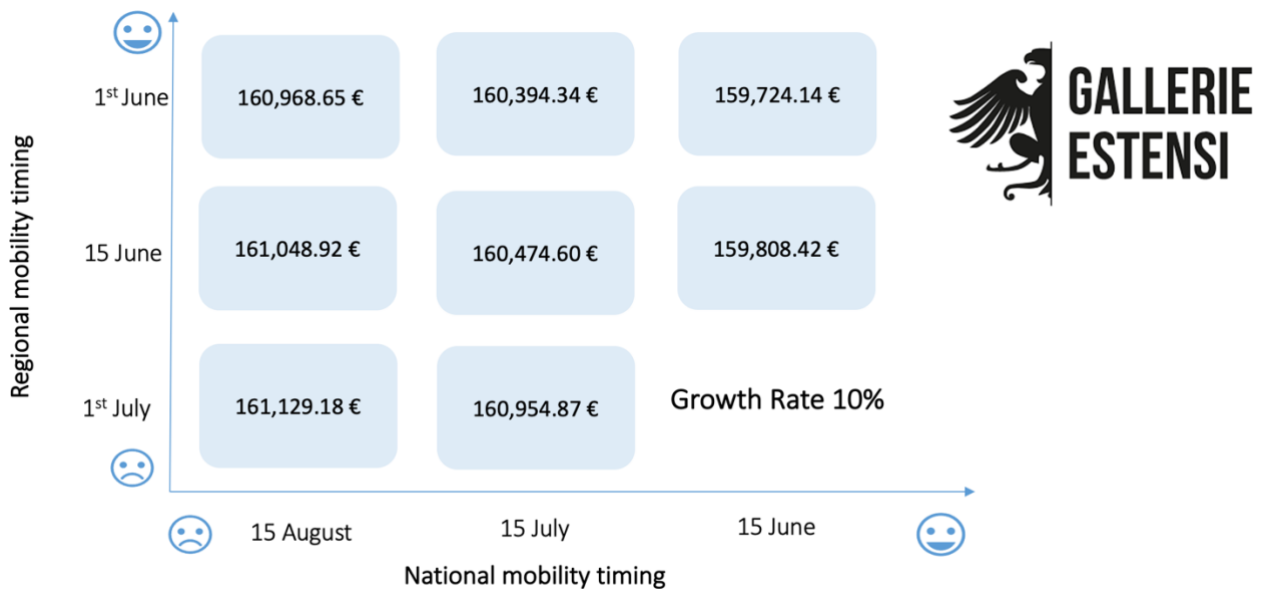


Figure 39: Economic loss for the Gallerie Estensi of Modena (from June to October, Growth Rate 10%)

At the end, the lower bound of the range is presented in the following Figure 40, which also contains the expected numbers in case of a Growth Rate posed at 20%.

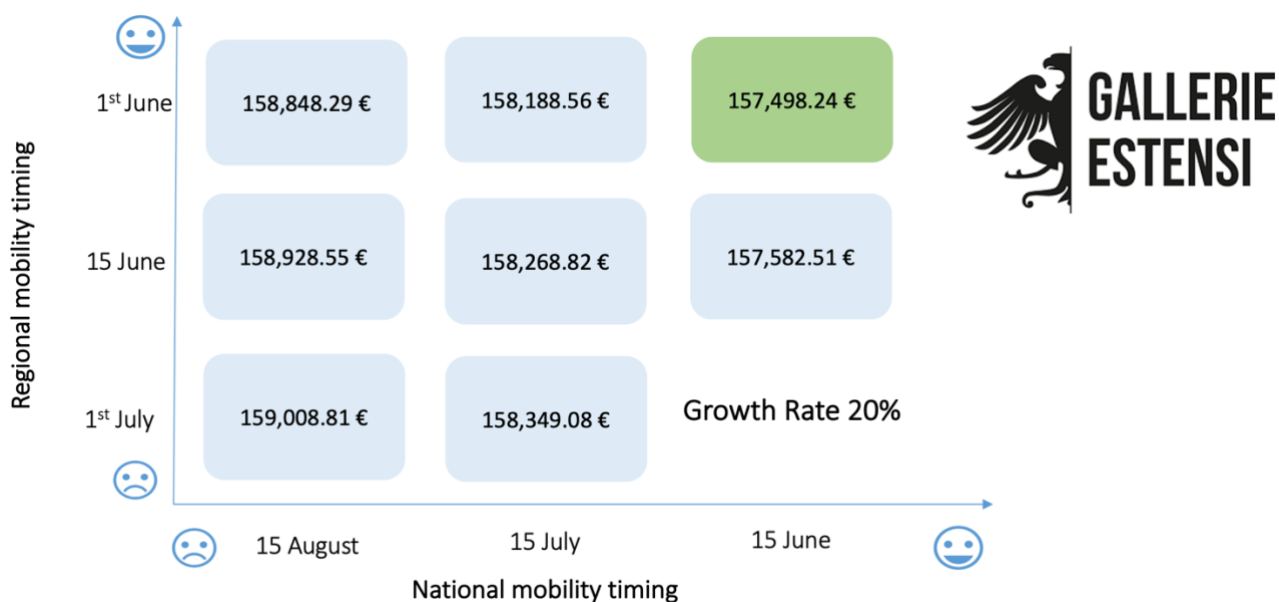


Figure 40: Economic loss for the Gallerie Estensi of Modena (from June to October, Growth Rate 20%)

The discussion of the results begins with the presentation of these in Table 17 below. This contains the forecasts and the actual results, both in terms of visitors and revenues registered. In particular, the Table also provides the number of visitors forecasted for each month from June to October 2020, with reference to a Growth Rate equal to 20%. This choice has been made considering an unexpected, from the points of view of both the working group and the Gallerie Estensi of Modena, growth in the number of visitors in the summer months (July and August in particular).

	Visitors forecasted	Visitors registered	Revenues forecasted	Revenues registered
Jun. 2020	526	868	€ 2,109.26	€ 2,125.00
Jul. 2020	455	1,801	€ 1,305.85	€ 2,714.84
Aug. 2020	818	3,450	€ 2,421.28	€ 6,026.76
Sep. 2020	2,555	2,597	€ 3,040.45	€ 4,624.00
Oct. 2020	3,677	2,710	€ 3,493.15	€ 5,112.92
Total	8,031	11,426	€ 12,369.99	€ 20,603.52
Computed losses	79,872		€ 149,284.01	

Table 17: Presentation of the results for the Gallerie Estensi of Modena

By looking at the Table, it is observable how the numbers registered for these months outperformed the respective forecasts, for a total of 3,978 visitors more than what expected, corresponding to almost the entire difference over the total forecasts. For sake of precision, it is necessary to mention the fact

that the last row of the Table includes also the sunk losses referring to the months from March to May 2020, in which museums were closed to the public.

According to the abovementioned formulas and the presented graph, in order to test the goodness of the model, ranges regarding both the number of visitors and the derived revenues have been computed, and these are readable in the following Table 18.

	Visitors	Revenues
Lower bound	83,267	€ 157,498.24
Upper bound	85,882	€ 160,685.61

Table 18: Ranges of analysis for the Gallerie Estensi of Modena

In this sense, the actual results are slightly out of the boundaries tracked by this analysis and it is therefore necessary to give an interpretation to this fact. As showed in the next Section, even for the Musei Reali of Turin the summer months presented a higher number of visitors registered and a consequently higher amount of revenues from ticketing (with respect to the forecasts), together with a reduction in October, because of the second wave of the pandemic. If the latter is attributable to the entry into force of the new containment measures, for the first event it is necessary to analyse the context concerning travels and tourism occurred in Italy after the generalized lockdown of the first wave of the virus.

With respect to the forecasts of the scenarios, a complete national reopening occurred as of the beginning of June 2020, resulting in a net increment of the mobility verified across the country. There are studies, such as the one which has been conducted by Bizzarri and Ceschin (2020), that tried to reconstruct the social mood and the willingness to travel of Italian people after the outbreak of COVID-19 pandemic. From a survey on the expectations about the mobility in the next future, “58.6% of the sample believe that it will not be possible to go too far, 13% cannot even imagine traveling and a quarter of the sample (24%) do not think of traveling again soon.” Despite this, at the end of August 2020, contagions in Italy have passed the thousand units per day and half of these, according to the Italian Ministry of Health, were related to returns from travels and holidays. These data have put the experts in front of a necessary reassessment, especially in the face of ordinary scenes of crowding and clogging at the main mobility poles, including stations and airports. The working group and the collaborating museums believe that, although the cultural sector is among the most affected by the current pandemic, the visitors expected have been positively influenced by this climate of greater freedom and easing of the restrictive measures, especially in the months immediately after the reopening.

5.2.3 The results of the Musei Reali of Turin

As done in the previous Section, in order to present the results, the graphs below contain the calculations adapted for each of the 24 scenarios generated by the model, computed with the same logic adopted for the Gallerie Estensi of Modena. The presentation starts with Figure 41, containing the number obtained considering a Growth Rate equal to 5%. These are, off course, expressed in terms of expected loss in terms of visitor attendance.

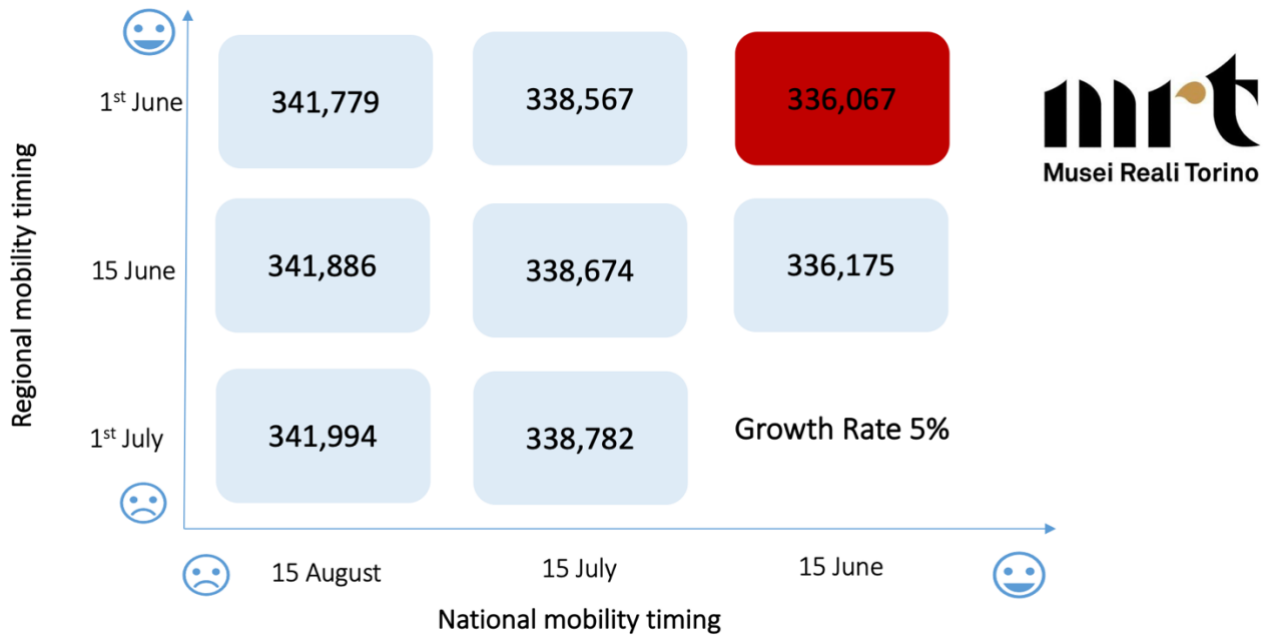


Figure 41: Loss in terms of visitors for the Musei Reali of Turin (from June to October, Growth Rate 5%)

These graphs, as previously said, are similar to the ones presented in Chapter 4, although not considering the months of November and December 2020 in the forecasted horizon. The red block represents the upper bound of the analysis range, being it the highest possible forecasted number of missed visitors, in a scenario in which the regional mobility is allowed from June 1, 2020, while the concession of travelling freely across the entire national territory is granted from June 15. This Section has been built with the same logic of the previous, adopting a uniform method for presenting the operating results of the museums to the reader. Therefore, the following Figure 42 is used to show the expected loss when fixing a Growth Rate equal to 10%, representing an intermediate situation between the two extremes of the lower and the upper bound respectively.

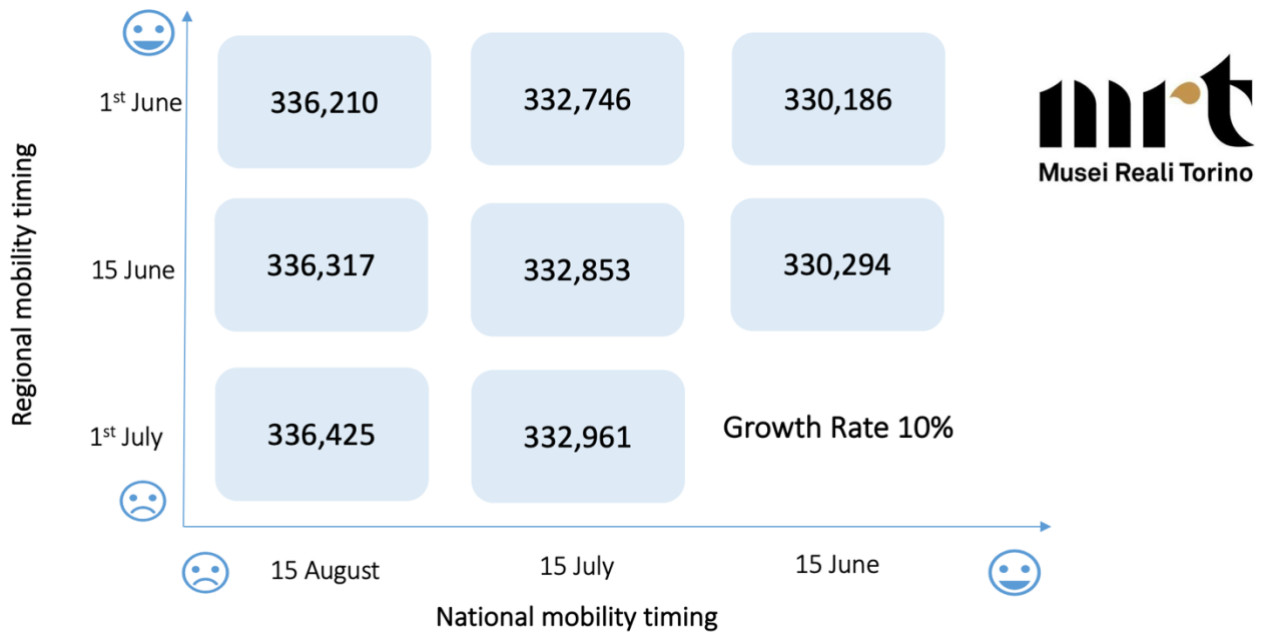


Figure 42: Loss in terms of visitors for the Musei Reali of Turin (from June to October, Growth Rate 10%)

Concluding this part, the lower bound of the range is contained in Figure 43 below, which also shows the expected numbers corresponding to a Growth Rate equal to 20%.

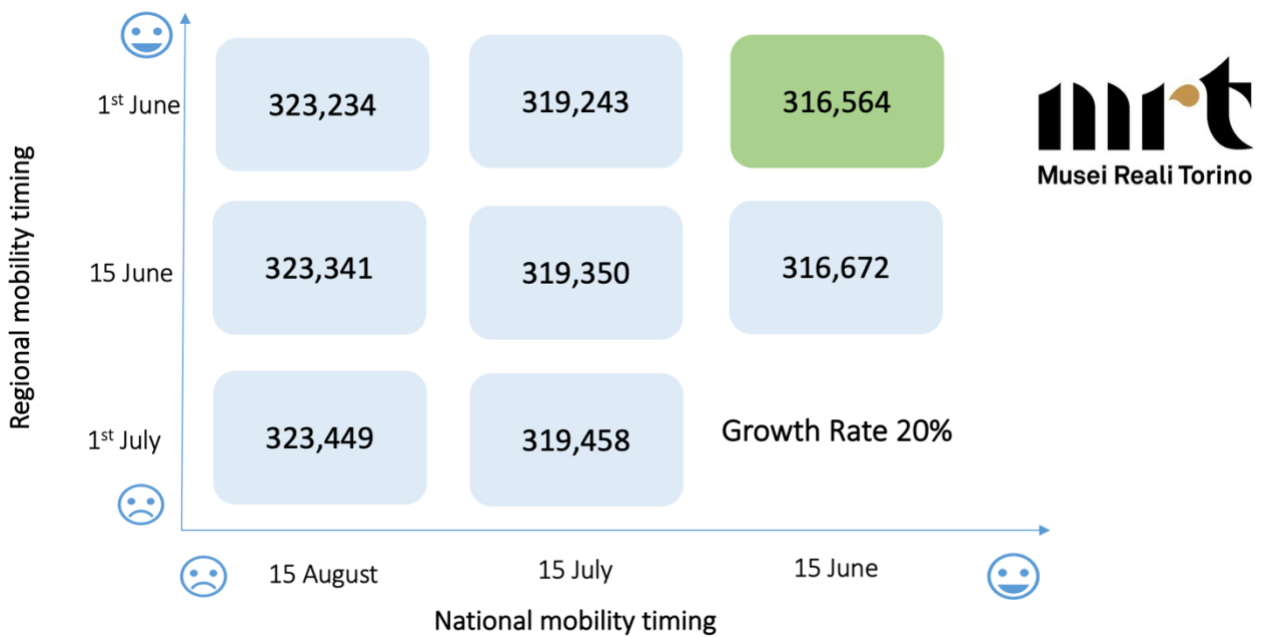


Figure 43: Loss in terms of visitors for the Musei Reali of Turin (from June to October, Growth Rate 20%)

After this, it is necessary to translate the losses regarding the missed audience into economic terms. The other graphs have been inserted in order to show this process of transformation, starting with Figure 44, which provides to the scenarios obtained with a value for the Growth Rate equal to 5%.

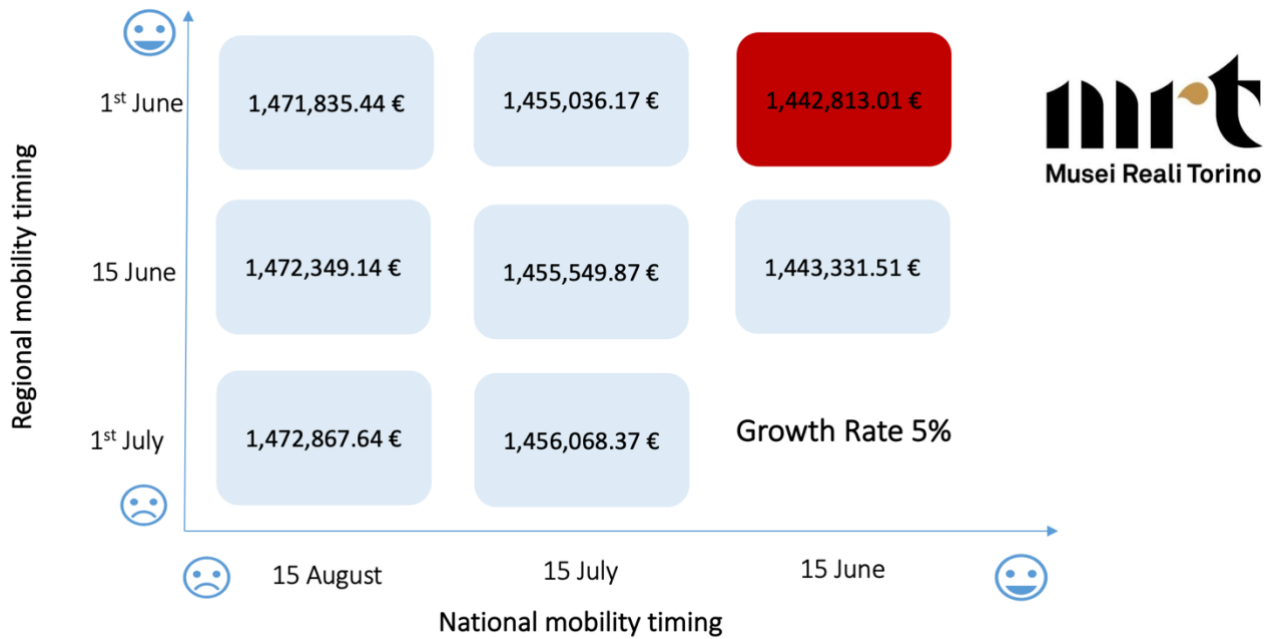


Figure 44: Economic loss for the Musei Reali of Turin (from June to October, Growth Rate 5%)

In this framework, the red block represents the upper bound for the range of the economic analysis, corresponding with the highest possible loss forecasted, in case of a regional reopening scheduled on June 1, 2020, and possibility of national mobility starting from June 15. Proceeding in this direction, Figure 45 has been inserted for reporting the same computations but with the Growth Rate posed equal to 10%.

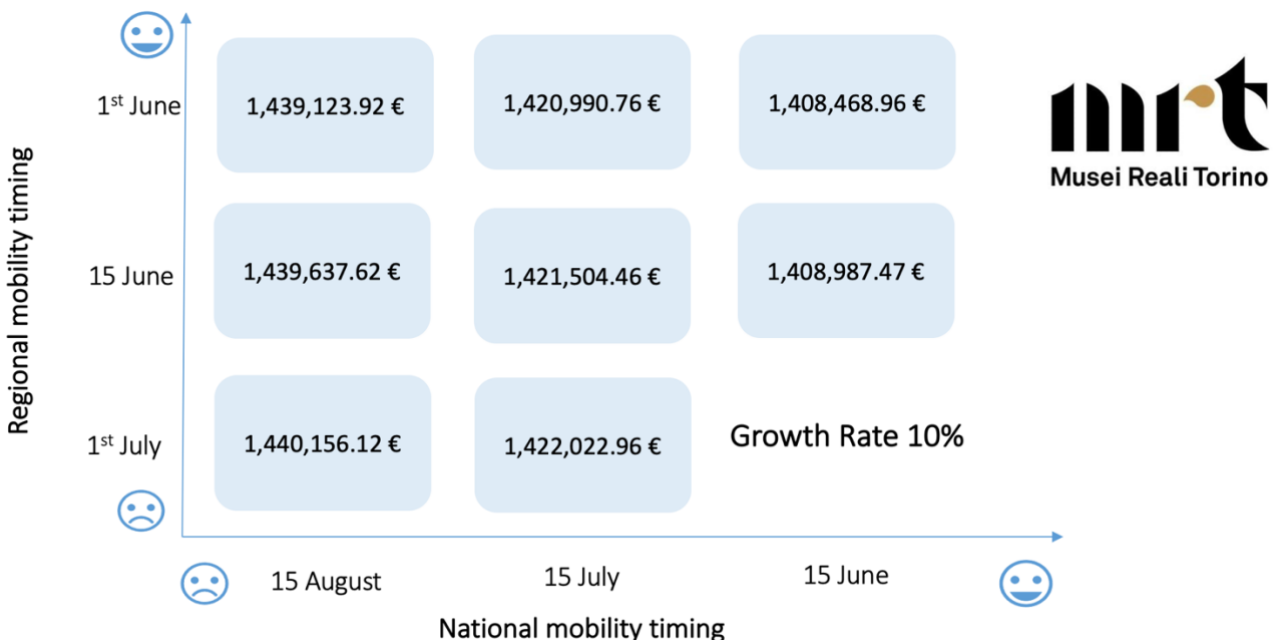


Figure 45: Economic loss for the Musei Reali of Turin (from June to October, Growth Rate 10%)

At the end, the lower bound of the range is presented in the following Figure 46, which also contains the expected numbers in case of a Growth Rate posed at 20%.

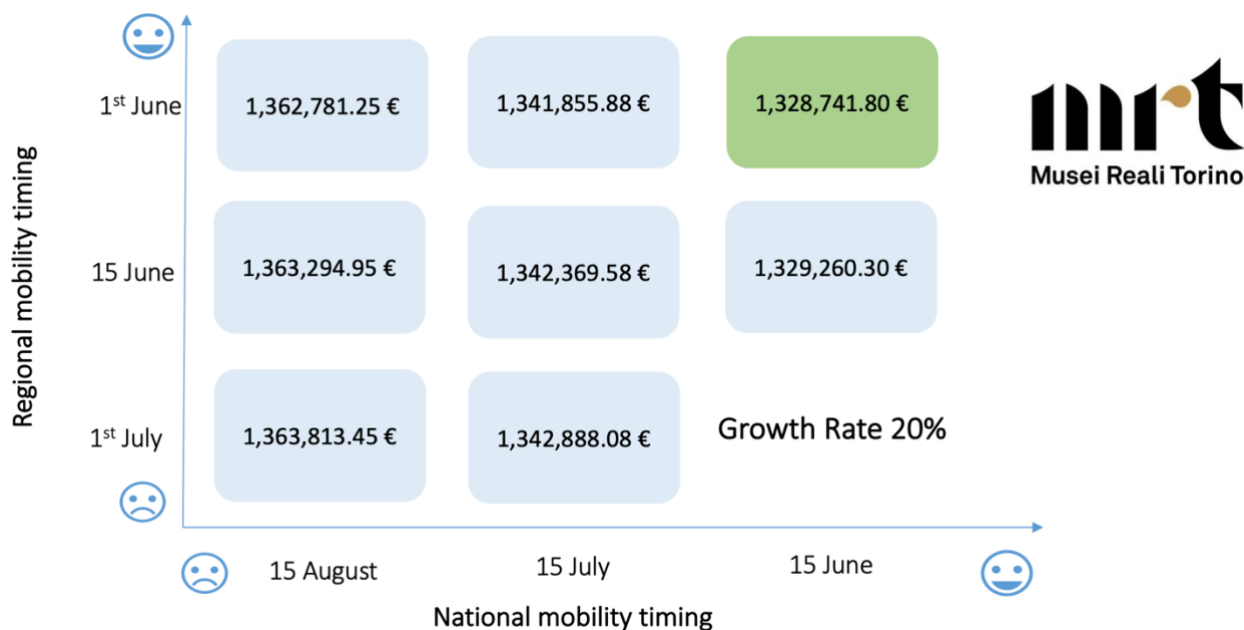


Figure 46: Economic loss for the Musei Reali of Turin (from June to October, Growth Rate 20%)

Having introduced these numbers, the discussion of results can start with Table 19 which, as done for the Gallerie Estensi of Modena in the previous Section, contains the forecasts and the actual results, in terms of both visitors welcomed and revenues cashed. Furthermore, the Table also provides the number of visitors forecasted for each month from June to October 2020, having adopted to a Growth Rate equal to 5%. This choice has been made according to the management and the personnel of this cultural institution, since they wanted to keep a low profile regarding these forecasts. Indeed, in the case of this particular museal institution, all the relevant sites and facilities are located only in the city territory of Turin, differentiating from the Gallerie Estensi of Modena, that have their visits place divided between Modena, Ferrara and Sassuolo, representing somehow a limitation, in the particular case of the reopening, according to the museum personnel point of view.

	Visitors forecasted	Visitors registered	Revenues forecasted	Revenues registered
Jun. 2020	6,448	6,650	€ 30,950.40	€ 25,797.00
Jul. 2020	7,734	7,692	€ 38,515.32	€ 48,793.00
Aug. 2020	12,096	14,185	€ 65,197.44	€ 94,786.00
Sep. 2020	10,808	12,617	€ 68,738.88	€ 78,985.00
Oct. 2020	13,275	10,017	€ 77,526.00	€ 69,043.00
Total	50,361	51,161	€ 280,928.04	€ 317,404.00
Computed losses	335,266		€ 1,406,351.88	

Table 19: Presentation of the results for the Musei Reali of Turin

Observing the Table, it is possible to notice how, as in the case of the Gallerie Esensi of Modena, the numbers regarding the summer months are higher with respect to the forecasts, even though the difference is smaller if compared to the total, with 3,856 units more with respect to the forecasts (occurred in the summer months) over 51,161 registered visitors. Moreover, due to the containment measures, October presents lower results with respect to the model, similarly to the previous case. Again, the last row of the Table includes also the sunk losses referring to the period from March to May 2020, corresponding to the months in which the generalized lockdown lasted.

Considering the model formulas, for assessing the goodness of the forecasts, the intervals of analysis concerning both the number of visitors and revenues from ticketing have been calculated and made available in the following Table 20.

	Visitors	Revenues
Lower bound	316,564	€ 1,328,741.80
Upper bound	336,067	€ 1,442,813.01

Table 20: Ranges of analysis for the Musei Reali of Turin

In this case, it is possible to notice how the actual results fit in the ranges of analysis for both the parameters considered, indeed:

$$316,564 \leq 335,266 \leq 336,067$$

And:

$$€ 1,328,741.80 \leq € 1,406,251.88 \leq 1,442,813.01$$

This means that the model has been able to provide a reliable assessment of the losses that a cultural institution such as the Musei Reali of Turin have had to face due to the ongoing COVID-19 pandemic. On the other hand, it is also necessary to consider the fact that a second wave of the pandemic occurred, bringing to new limitations and thus presenting a new scenario of closure for the Italian cultural sites, leaving also this analysis untermiated. The next Paragraph is aimed to present this new emergency situation, briefly describing it from an institutional point of view, presenting the general context and the measures undertaken by the Italian government to face the second coming of the virus. This has been inserted coherently with the choice of reporting the timeline of events which characterized this pandemic period and influenced the development of the model, which are described in the literature review and continue in Paragraph 5.1 as well.

5.3 The second wave of the COVID-19 pandemic in Italy

This Paragraph is aimed to provide a quick overview on the health and social situations in Italy after the second wave of the COVID-19, occurred starting from the last part of the year 2020. In order to be as clear as possible to the reader of this Master Thesis document, the information here contained are the most updated ones provided by the Italian government at the beginning of December 2020. As a response to the rise in the contagion curve (Figure 47), which on 7 October 2020 reaches 3,678 new positives, the Prime Minister Giuseppe Conte announced the same evening a new Decree, in force since October 8, which confirms the previous containment measures and also extends the state of emergency until January 31, 2021, making the use of masks mandatory both in outdoor and indoor places, except for private homes and for circumstances in which continuous isolation from people is guaranteed not living together. Those who are doing sports, children under the age of six and those with pathologies or disabilities incompatible with the use of the mask are exempt from this obligation. Regions can only take more restrictive measures than national ones and not loosening ones.

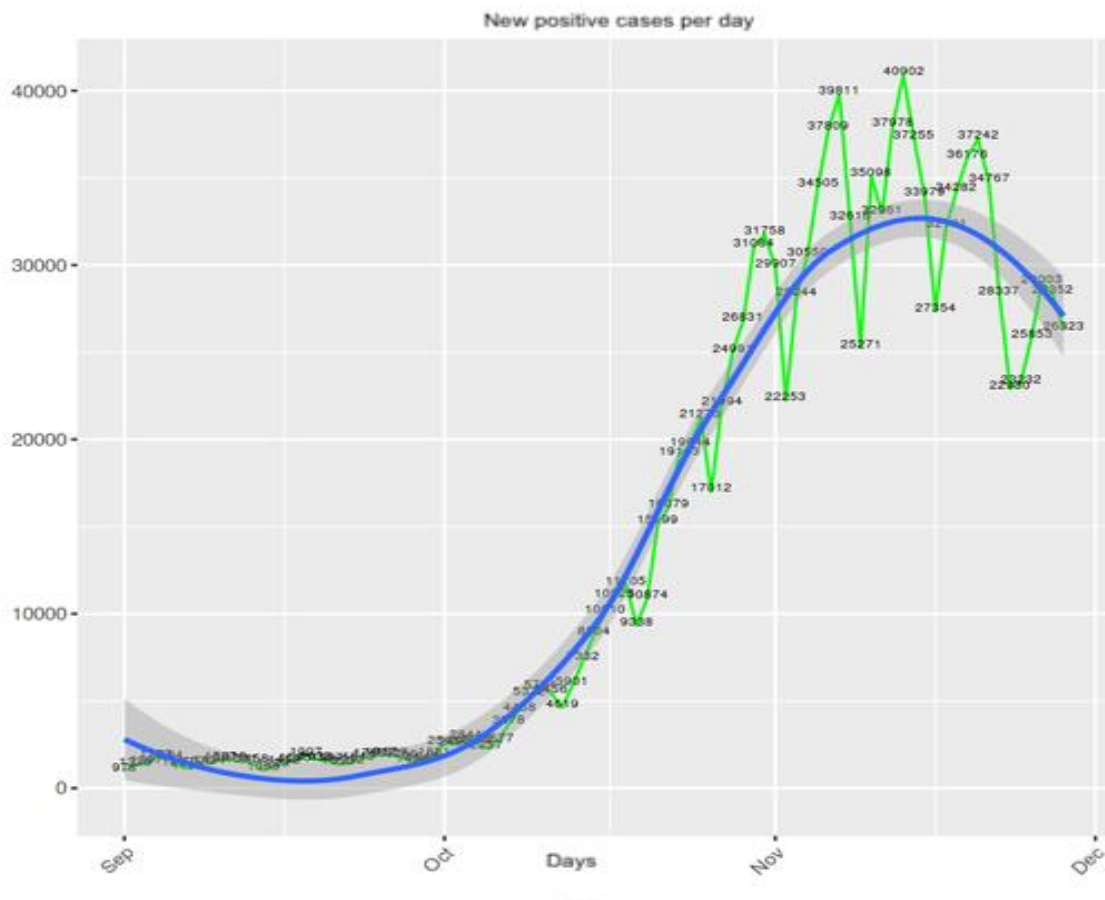


Figure 47: Contagions curve during the second wave of the pandemic in Italy (source: kaggle.com)

A new DPCM in force from October 13, 2020 also recommends compliance with the safety measures (interpersonal distance and use of face masks) even in private homes in the presence of non-cohabiting people, and also strongly recommends the avoidance of parties and not to host more than 6 people not living together in their own home. This Decree introduced more restrictive measures than the previous ones: it reaffirms the prohibition of gathering outdoors and indoors; allows public events to be held only in static form; sets the number of spectators for nationally and internationally recognized sporting events and competitions, as well as for theatrical performances, concerts and film screenings at 1,000 outdoors and 200 indoors; prohibits amateur contact sports; sets the maximum number of participants at 30 individuals for civil or religious ceremonies; suspends educational trips, exchanges and twinning, guided visits and school outings; limits the access of relatives and visitors to hospitality facilities such as nursing homes; allows the attendance of restaurant services only until 9:00 p.m. without consumption at the table and until 12.00 a.m. with consumption at the table; encourages smart working.

On October 18, 2020, the Premier signed a new Prime Ministerial Decree that allowed Mayors to dispose the closure of streets and squares in urban centres, where gathering situations can be created, after 9:00 p.m.; prohibits conferences or congress activities, together with community festivals and fairs that are not of national or international interest; allows high schools to organize distance learning activities, complementary to those in the presence, and universities to organize their activities based on the epidemiological situation of the territory.

Starting from 22 October 2020, the Lombardy Region imposed a curfew from 11.00 p.m. to 5.00 a.m. the next morning, therefore forbidding to move except for situations of necessity, work or health reasons; the same measures are also adopted, starting from 23 October, also by the Campania Region (curfew from 11.00 p.m. to 5.00 a.m.), by the Lazio Region (curfew from 12.00 a.m. to 5.00 a.m.), starting from 25 October by the Sicily Region (curfew from 11.00 p.m. to 5.00 a.m.) and, starting from 26 October, by the Piedmont Region (curfew from 11.00 p.m. to 5.00 a.m.).

On the night of October 24, 2020, President Giuseppe Conte signed another Prime Ministerial Decree, in force from October 26 to November 24, which added to the measures adopted the closure of gyms, swimming pools, swimming pools and wellness centres; closing at 6.00 p.m. catering activities; the closure of theatrical, concert and cinema halls, including outdoors; the closure of arcades, betting rooms, bingo halls and casinos; the increase of integrated digital teaching for high schools and entry, to high schools, not before 9.00 am. The Decree also strongly recommends *"not to travel by public or private means of transport, except for work, study, health reasons, situations of necessity, to carry out activities or use unsuspending services"*.

On the evening of November 3, 2020, the fourth DPCM belonging to the second wave period was signed. The Ministerial Decree, in force from November 6 to December 3, 2020, providing for a curfew throughout the national territory from 10.00 p.m. at 5.00 a.m., with movements allowed only for work needs or proven reasons of health and necessity. It also included the closure to the public of exhibitions, museums and other places of culture (such as archives and libraries), the use of distance learning for upper secondary school, the suspension of public and private competitions that do not take place in telematics, the closure of shopping centres and medium and large sales structures on holidays and pre-holidays, the reduction to 50% of the capacity of public transport (excluding school transportations), in addition to the suspension of all other activities already contained in the previous decrees. The DPCM establishes four different risk scenarios, depending on the description in Table 21 below.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Rt values	Rt<1	Rt=1-1.25	Rt=1,25-1,5	Rt>1,5
Issues	Identifiable and controllable outbreaks	Identifiable and controllable outbreaks	Rapid growth of cases	Exponential growth of cases
		Relative difficulties in tracking cases	Difficulties in tracking cases	Case tracking impossible
			First signs of hospitals overload	Hospitals overload

Table 21: Description of the risk scenarios according to the DPCM of November 6, 2020

Furthermore, stricter measures for the advanced Regions to "Scenario 3" and "Scenario 4", identified as such by the Technical-Scientific Committee. These measures were issued with an order of the Minister of Health, in agreement with the president of the Region concerned, and must have a minimum duration of 15 days, which in any case does not go beyond December 3, the last day of effectiveness of the Prime Minister Decree.

In the Regions (or parts of them) advanced to "Scenario 3", also known as "Orange Areas", that is, "with Rt values between Rt equal to 1.25 and Rt equal to 1.5 and in which it is possible to limit only modestly the transmission potential of the virus with ordinary and extraordinary containment measures", the curfew is valid from 10.00 pm at 5.00 am, any movement outside the Municipality of

residence is forbidden, except for work needs or proven health or necessity reasons, and catering services are suspended (only take-away is allowed until 10.00 pm, and home delivery). All other activities not mentioned (such as shops and schools up to the eighth grade) remain active, as for the "Scenario 2". In the Regions (or parts of them) instead advanced to the "Scenario 4", also known as "Red Areas", with R_t values greater than 1.5, for which it is impossible to trace new cases and the overload of welfare services occurs, the prohibition of travel even within the Municipality of residence, the suspension of catering services, the retail trade activities and the markets are closed, and distance learning is introduced starting from the second grade. Personal services remain active, such as hairdressers and laundries. A breakdown of Italian regions and autonomous provinces in risk scenarios according to this DPCM is provided in Figure 48.

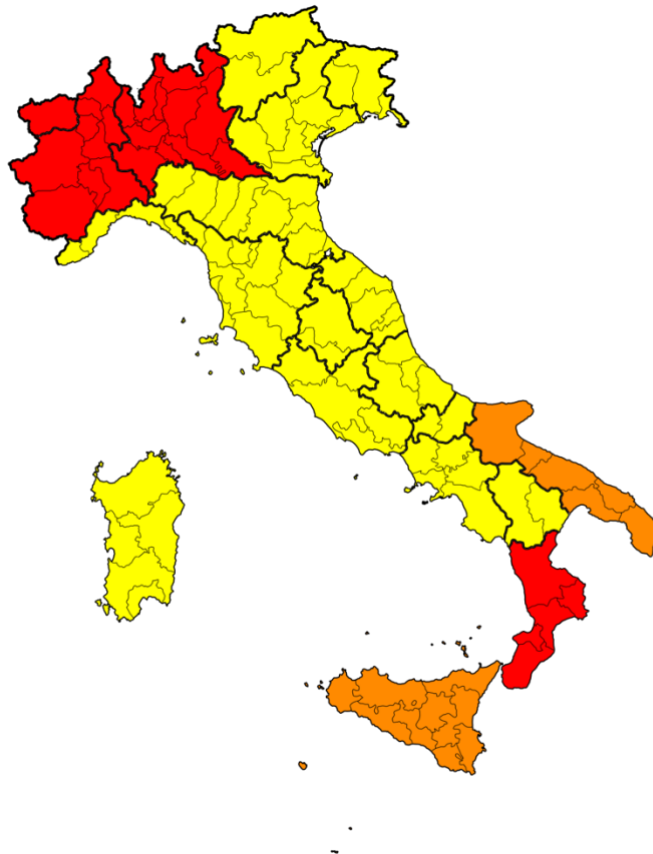


Figure 48: Division of the Italian Regions according to the DPCM of November 6, 2020

On the evening of December 2, 2020, a new Decree-law is approved, in force from the following day, which allows the possibility of extending the validity of the containment measures for a period of 50 days. To contain the spread of the contagion during the Christmas holidays, the same Decree prohibits any movement into or out of the Regions or Autonomous Provinces, to any scenario they belong,

starting from December 21, 2020 and until January 6, 2021, and any movement outside their Municipality of residence on 25 and 26 December 2020 and 1 January 2021.

On the evening of December 3, 2020, Prime Minister Giuseppe Conte announces the new Prime Ministerial Decree, in force from December 4, 2020 to January 15, 2021, which confirmed the classification into three risk bands for the regions and autonomous provinces.

As already mentioned, if an insight on the underlying context is fundamental when dealing with such an uncertain situation, the main objective was to build an instrument capable to assess the economic impact of COVID-19 pandemic over cultural institutions and to help them in managing this out of the ordinary situation. This Chapter, even though the analysis has been interrupted by the presented dispoasures undertaken for containing the second wave of the pandemic, served as proof that the Multiple Scenarios Model is able to provide a reliable assessment of the impact that measures in response to a health emergency might have on museums, considering both the closure period itself and the consequent transitory phase after a reopening.

When tackling an extremely complex topic such as the second wave of COVID-19, it would be necessary an additional part of this Master Thesis document entirely dedicated to the forecasts and possible outcomes that this terrible situation might bring, focusing firstly on the economic system in general and then on the cultural environment. In this case, the risk is to just increase the length of the document, providing mere previsions about an uncertain future, without adding concrete contents to improve the Multiple Scenarios Model and, therefore, going out of the principal topic.

With this short Paragraph it is possible to declare concluded the analysis related to the discussion of the presented model. In the perspective of another application, in the face of what has just been presented concerning the new restrictions deriving from the second wave of the virus, the general framework and formulas are the ones introduced in paragraph 4.3. Again, these are not aimed to be a mandatory rule to follow in order to apply the Multiple Scenarios Model, but they have to be considered as a guideline through which computing the different scenarios. The case presented in this Master Thesis is the starting point of a wider span of research concerning the cultural heritage and the ongoing pandemic. Only through multiple and various applications this model can be improved and be an important tool for the management of the post COVID-19 cultural fruition.

6. Conclusions

This final Chapter has been introduced in order to conclude the present Master Thesis, highlighting its findings, as well as discussing the academic contributions and implications that this research project brought, from the point of view of both museum practitioners and policymakers. At the end, after presenting the main limitations, some alternatives for future research are also provided.

In the middle of a global pandemic, this Master Thesis pursued the objective of supporting cultural heritage institutions, in particular museums, in managing this extraordinary situation. In particular, the focus has been posed on the economic impact that the COVID-19 outbreak would have brought to the cultural sector.

It has been possible to synthesize the principal objectives with the following research questions:

1. Which numbers or indicators can be used for assessing the economic impact of the COVID-19 over museums, that can be easily read but complete at the same time?
2. How is it possible to foresee potential evolution of the current scenario (as of March 2020)?

As already mentioned, this research project was born after an explicit request to Politecnico di Milano, made by three northern Italian museums: the Gallerie Estensi of Modena, the Musei Reali of Turin and the Palazzo Ducale of Mantua. Despite its nature, which is strictly related to the reality of the three mentioned cultural institutions, this research always aimed to be suitable for every cultural institution worldwide, not being exclusively applicable to the Italian context. Therefore, after a broad review of the existent literature on museums, as well as on the potential impact that a pandemic might bring and on the virus itself, a specific tool has been developed in order to answer the aforementioned research questions. This instrument consists in a Multiple Scenarios Model in which, for each possible generated outcome concerning the underlying environment in terms of number of visitors, the economic impact is assessed on the basis of the difference between the potential incomes obtainable in this pandemic situation, and the ones which would be possible to earn in normal conditions. Then, for validating the proposed model, data coming directly from the collaborating institutions have been gathered and analyzed. In particular, the results in terms of both visitors and consequent revenues registered during the reopening period after the first wave of the COVID-19 pandemic, have been compared with the forecasts generated a priori by applying the Multiple Scenarios Model to these northern Italian museums. Basically, the forecasts led to identify ranges in which the economic loss of museums should have been included and, in order to test the goodness of the computations, it has been verified whether the forecasts have actually resulted within these intervals.

6.1 Master Thesis findings

The findings of the present Master Thesis can be divided into two main parts: the first regards the pure economic impact assessed through the application of the discussed Multiple Scenarios Model, the second concerns the identification of the related challenges that cultural institutions, in particular museums, will have to face in order to exit this crisis situation.

If, on the one hand, the fact that closures and restrictions due to the COVID-19 pandemic would have gone to create damages to the revenue streams of cultural institution was already a certain fact with no need of any demonstration, on the other hand the Multiple Scenarios Model demonstrated that it is possible to obtain a rapid assessment of these losses, resulting in an instrument of easy usage and somehow “customizable” according to the parameters of the cultural institution willing to choose it as a supporting tool in the management of the emergency. In particular, the process of development of this model highlighted two main facts:

- As of today, except from certain particular cases, revenues from ticketing still represent the main sources of income as regards cultural institutions. There is an obvious direct relationship between the number of visitors and the revenues generated and it is therefore possible to obtain a sufficiently reliable assessment of the economic impact of COVID-19 for museums, even avoiding the implementation of a more sophisticated forecast system;
- There are several factors to be taken into consideration when comparing the normality of the pre-pandemic to the new life standards introduced by the COVID-19 emergency, moving from the economic field to the socio-psychological sphere. To the extent of the discussed model, the general term “mobility” has been used, in order to synthesize the repercussions of the pandemic on the potential audience that might have visited museums. In particular, relating only to the three northern Italian institutions and the way in which the first generalized lockdown has been carried out in Italy, three levels of allowed mobility have been considered: Province, Region and Nation. The underlying idea is that, on the basis of the contextual changes, legislators will adapt the necessary restrictions, resulting then in an increase or a reduction of the potential public.

Secondly, even though it is not the primary goal of this Master Thesis, it is also necessary to consider the mechanisms that museums will put into force in order to fight the difficulties imposed by the restrictions and the containment measures, adapting themselves to the “new normal” of the post-COVID era. In fact, the simple calculation of potential losses as an end in itself would not fully satisfy the final goal of this Master Thesis, which aims to help cultural institutions in managing the crisis and preparing to a subsequent restart. This has been, for example, analysed by Agostino, Arnaboldi

and Lorenzini (2020), which posed their attention on the importance and the centrality that digital innovation must have in the actual museum management. They showed how, during the weeks of closure and the inability to reach museums, digital has become the tool of cultural delivery. In particular, it has been the social media channels that became the reference for cultural fruition, no longer representing a communication tool, but becoming a real means for providing and enjoying culture. During March and April 2020, the average volume of posts published by museums on social media channels doubled compared to the previous months with an average of 40 posts per month per museum on Facebook (it was 25 posts per month in February 2020), 60 tweets per month per museum on Twitter (it was 32 tweets per month in February 2020), 33 posts per month per museum on Instagram (it was 15 posts per month in February 2020). In terms of response from the digital audience, the 100 museums monitored in this research saw their followers on Facebook grow by 8.7% between March and April 2020. In the same period, the average growth per museum of their followers has been 5.2% on Twitter and 15.6% on Instagram.

In this context, digital and social media channels in particular, allowed the museum to enter everyone daily life, increasing interest in the cultural offer by new audiences. It is clear that this situation remains confined to those weeks, however this virtuous experience on the use of digital by museums leads to a broader reflection on the potential offered by digital to make museums accessible, inclusive and safe in the future scenario. Concluding, the researchers stressed how, in approaching this phase of “museal new normal”, their contribution will continue to be focused on monitoring the adoption of digital by museums, on the analysis of virtuous experiences and on monitoring the perceptions of digital audiences.

6.2 Master Thesis contributions

This Paragraph contains the principal contributions that the present Master Thesis brought. In particular, two main aspects have been analysed, according to which the following two Sections have been derived. Firstly, the academic contributions have been reported, focusing on those aspects that have been identified as a gap at the end of the literature review and that this Master Thesis pursued to fill. Secondly, taking a more concrete perspective, also the practical implications emerged have been highlighted, presenting the impositions that the COVID-19 made to the places of culture and how the discussed model can actually be a useful instrument for museums practitioners and, eventually, policymakers.

6.2.1 Academic contributions

In Paragraph 3.1, two research questions have been posed, the answer to which is the key in order to fill the main gap identified: the absence of a direct assessment method to measure the economic impact of a pandemic over cultural heritage. The presented Multiple Scenarios Model represents the answer, from the working group, to those initial questions and a synthesis of these is also reported in Table 22 below.

Academic Gap	Academic Contributions
Which numbers or indicators can be used for assessing the economic impact of the COVID-19 over museums, that can be easily read but complete at the same time?	In order to keep the analysis both complete but easy to be read at the same time, the model exploits the number of expected visitors as main parameter to compute the expected losses due to the COVID-19 pandemic
How is it possible to foresee potential evolution of the current scenario (as of March 2020)?	This will still remain a difficult to manage parameter, due to the high uncertainty of the context. However, the model basis the changes in terms of potential available audience by exploiting the general concept of “allowed mobility”

Table 22: Academic contributions

Furthermore, in the same Paragraph also other issues have been discussed. Indeed, when introducing the synthesis of the literature review as an essential process for knowledge widening, the main difficulties making this process more complex have been listed. These find their roots in the difficulty of the considered topic and in its constant uncertainty. They have been classified into three blocks and now, by scrolling to the previously introduced list, it is possible to provide the reader with a quick overview on how the working group coped with these difficulties, retaining also this part as a relevant contribution in order to perform future research:

- *The “distance” in terms of research topics:* the main problem, from an academic point of view, has been that the focus of the experts was initially posed on “the big picture”, trying to find a way to contain damages the most. Then, experts (both academic and non-academic) started to publish research and estimates about the impact of the pandemic on the various sectors and micro-sectors.

Since the health emergency is still ongoing, studies and papers are daily published, coming from various sources and focusing on different fields. As a matter of fact, one of the biggest challenges for the working group has been to balance the trade-off between the choice of the most recent documentation and the risk of overloading this document with too many information that would have led the focus out of the main topic supposed to be addressed;

- *The newness and uncertainty of the context:* this issue, in addition to the fact that no member of the working group had humanistic or medical competences, made the addressment of the discussed topics tougher. Moreover, even though as of today experts themselves have a wider knowledge of COVID-19 and its main implications, together with the fact that, with the discovery of the vaccines, the end of the pandemic seems closer, the underlying context still presents a high level of uncertainty and forecasting possible outcomes is still a complex task. Complementary to the literature review process, a helpful behaviour has been to stay as updated as possible on the topic, exploiting also untraditional sources of information, such as the ones made available by the usage of social media. However, if these have the advantage of being fast accessible and easy to read, a fundamental aspect is represented by the ability to recognize and not to trust the so-called fake news, which deviate the researcher to the actual widening of its knowledge;
- *The focus of already existing contributions:* if models discussing the potential economic impact that a pandemic might generate are by large number available, these were not entirely suiting the goal of this Master Thesis, being the cultural heritage sector just a small part of the entire economic system. Moreover, another objective was to avoid extremely complicated forecasting procedures, in order to keep the reading of the Multiple Scenarios Model quite easy for museums practitioners. In this sense, the direct contact with the management and the personnel of the requiring institutions (even though only virtual), facilitated the development process. Indeed, the possibility to have a constant feedback from people working on the field and, basically, representing the final users of this model, has been an important advantage towards the accomplishment of the declared Master Thesis objective.

6.2.2 Practical implications

The developed model demonstrated that it is possible to assess the economic impact of an out of the ordinary situation such as the outbreak of the COVID-19 pandemic, relying on both quantitative and qualitative aspects. Moreover, its main advantage is represented by the easiness of usage and the velocity in which the results are computed. Before moving to the main challenges and implications that COVID-19 generated for museums practitioners, it is also possible to focus on the key point around which the present Master Thesis has entirely been built: Coronavirus had an impact on the

cultural heritage sector. With reference to what showed in Chapter 5, in which computed forecasts have been compared to the actual numbers of museums in order to test the goodness of the Multiple Scenarios Model, Table 23 below contains the difference between the numbers at their first reopening and the ones referring to the same period of the previous year 2019. Precisely, the months considered are the ones between the first reopening (after the Italian generalized lockdown) and the second closures due to the second wave of the virus, thus excluding those months in which museums have been closed and the number of visitors has been obviously equal to zero.

	Gallerie Estensi of Modena		Musei Reali of Turin	
	2019	2020	2019	2020
June	6,973	868	29,569	6,650
July	4,142	1,801	28,306	7,692
August	6,196	3,450	42,161	14,185
September	16,121	2,597	35,876	12,617
October	19,338	2,710	41,963	10,017
Total	52,770	11,426	177,875	51,161

Table 23: Losses in terms of visitors from 2019 to 2020 (June-October)

Then, as showed in the present Master Thesis, it is possible to transform the reduction in terms of audience into economic loss for missed revenues. Table 24 synthesizes these numbers for both the northern Italian museums which participated to the validation phase of the developed tool, presenting the percentage loss of visitors and, consequently, in terms of revenues with respect to the last year (referring to the aforementioned period of analysis).

	Gallerie Estensi of Modena		Musei Reali of Turin	
	Visitors	Revenues	Visitors	Revenues
2019	52,770	€ 95,886.30	177,875	€ 983,442.84
2020	11,426	€ 20,603.52	51,161	€ 317,404.00
Losses (%)	78.34%	78.51%	71.24%	67.73%

Table 24: Generalized losses with respect to 2019 (June-October)

In light of this, even though this short analysis over a sample of only two museums cannot be assumed as a punctual assessment of the COVID-19 impact over the entire cultural heritage sector, it is however relevant to notice how, looking at the actual numbers, the losses in terms of both visitors

and revenues exceed, on an average, the 70 percent. As a consequence, some obvious questions arise, above all:

- How will museums adapt themselves to this “new normal” in order to restart and leave this crisis situation behind?
- Which are the keys to success in doing this and the main hurdles to overcome?

Recalling the contents presented by Agostino, Arnaboldi and Lorenzini, again, one of the most important pillars will be digital innovation. However, in the pre-COVID scenario, a strategic and structured adoption of digital in museums was a privilege for few of them. In fact, out of a sample made of 422 museums, only 6% had a strategic plan dedicated to digital innovation, 3% declared that they allocate more than 50% of their investment budget to digital, and digital skills were heterogeneous with 37% of museums having figures dealing with digital, but without a dedicated team. The only exception is represented by social media channels, with 76% of museums present on at least one social media channel, a percentage that grew by 22% between 2017 and 2020. Skills on social media are also the most widespread with 84% of museums who said they have an internal or external social media manager.

In this sense, it is clear how policies and managerial choices must be oriented to focalize investments in order to fill these relevant gaps in terms of digital technologies and skills. Then, it is also necessary to consider the ways in which the “new normal” of cultural fruition will be realized. Always referring to the three aforementioned authors, three specific declinations have been proposed:

- *Phygital fruition*: where physical and digital experience are integrated, maintaining a constant and continuous relationship between the museum and its audiences (Ballina et al., 2019). For example, the visitor begins the online experience by using some content on the collections, then in the museum he benefits from a dedicated path, which continues with further post-visit online insights;
- *Personalized and on demand fruition*: in which the visitor will select the content that best suits its needs and use it independently. This requires the profiling of online users and their habits in order to be able to offer, on online platforms (possibly integrated with other sectors), content created ad hoc for them. It has been quite common in this particular period the idea of a Netflix of culture (G. Ronchi, 2020), to precisely underline the potential of digital to reach everyone in their homes with personalized contents;
- *Fruition accessible to generation Z*: one of the most debated elements is the trade-off between the elitist considered context of cultural content and the need to make cultural heritage accessible to

generation Z. Being digital is an identifying element of post-millennials, which can facilitate the approach to culture and the accessibility of cultural heritage by this generation. In this direction, it is possible to mention cultural gaming initiatives (Lampis, 2018; Solima, 2018) or the opening of social channels targeting millennials, such as the choice of the Uffizi Galleries to create an account on Tik-Tok.

In this context, the skills necessary for museum management are increasingly integrated and require knowledge of cultural heritage, as well as the knowledge of digital technologies and the supervision of managerial tools. The definition of new competence profiles for museum professions is increasingly necessary today, with the supervision and knowledge of digital that must represent a transversal element in training courses. For these reasons, it is therefore possible to underline, once again, how investments in new professional figures, new technologies and new tools are fundamental in order to bring an effective change of the cultural paradigm.

6.3 Limitations and future research

The main limitations concerning this research project rely on the methodology adopted, particularly when applying it to the three aforementioned northern Italian museums. Above all, the two main problems identified by the working group are:

- *The adopted forecasting technique:* in Chapter 4, it has been pointed out that the method chosen in order to compute the forecasts about the number of visitors does not have to represent a constraint in the application of the Multiple Scenarios Model. However, in the particular case presented in this Master Thesis, the adopted OLS method may result in an extremely simplistic representation. This choice has been driven from the rush, in the very first days of development, of quickly obtaining data to analyze and from the museums themselves, which required calculations not too complicated to be interpreted;
- *The qualitative approach in estimating Growth Rate values:* this is one of the key parameters of the presented model, weighting how the audience will grow overtime. For the same reasons discussed in the previous point, the choice made by the working group results in an extreme simplification of this parameter. Indeed, even though agreed with the collaborating institutions, presenting a fixed range of only three possible values may not be considered satisfactory for subsequent studies. To overcome this issue, a more direct approach towards the public can be a possible solution, being this coefficient synthesizing their willingness to join, again, the place of

culture. As an example, in the ambit of this research project, the working group also created a short survey that these northern Italian museums submitted to their audience through social media channels and newsletters. For reasons due to the timing and the fact that, at that time, a lot of questionnaires have been proposed to the general public, the number of responses has been quite low and, therefore, the sample has not been retained sufficiently reliable in order to introduce these results in the present Master Thesis. However, this can be considered as a starting point for future improvements and the mentioned survey is available in the Appendix.

As regards possible future research, one direction is surely the one concerning further improvements to the Multiple Scenarios Model. In particular, by observing the actual evolution of the current events, it will be possible to refine the way in which the modelling is carried out, providing a more accurate possible evolution of the scenarios (e.g. not limiting it to only monitoring the trend regarding allowed mobility).

Then, the Multiple Scenarios Model can also be applied to other cultural institutions. These institutions are not forcedly supposed to be just museums, since is also possible to consider other places of the culture such as libraries, archives, archaeological areas and parks, exhibitions, theatres and cinemas. Moreover, a further goal is that the developed model can be a useful tool and therefore be applied to cultural institutions located abroad as well, not resulting in an application solely suitable to the Italian context.

Appendix

A. Musei Reali of Turin & Palazzo Ducale of Mantua price range

Regular ticket	€ 15
Reduced ticket (18-25 years old)	€ 2
Free ticket	Schools, people with disabilities and relative companion, journalists and tourist guides with card, young people under 18 years old, ICOM members, MIBACT staff, teachers and students.

Table 25: Musei Reali of Turin tickets price

Regular ticket (Palazzo Ducale only)	€ 6.50
Regular ticket (Palazzo Ducale + Camera degli Sposi)	€ 13
Reduced ticket (18-25 years old)	€ 2
Free ticket	Schools, people with disabilities and relative companion, journalists and tourist guides with card, young people under 18 years old, ICOM members, MIBACT staff, teachers and students.

Table 26: Palazzo Ducale of Mantua tickets price

B. Musei Reali of Turin & Palazzo Ducale of Mantua monthly revenues per visitor

Month	Revenues	Number of visitors	Coefficient
Jan. 2019	€ 194,875.84	40,148	4.85
Feb. 2019	€ 159,523.25	37,280	4,28
Last week of Feb. 2019	€ 43,329.56	30,708	1.41
Mar. 2019	€ 152,340.58	65,505	2.33
Apr. 2019	€ 249,579.73	48,233	5.17
May 2019	€ 167,896.25	40,710	4.12
Jun. 2019	€ 141,959.00	29,569	4.80
Jul. 2019	€ 140,883.68	28,306	4.98
Aug. 2019	€ 227,331.15	42,161	5.39
Sep. 2019	€ 228,042.93	35,876	6.36
Oct. 2019	€ 245,226.08	41,963	5.84
Nov. 2019	€ 203,677.46	42,585	4.78
Dec. 2019	€ 251,142.54	46,353	5.42

Table 27: Revenue per visitor for Musei Reali of Turin

Month	Revenues	Number of visitors	Coefficient
Jan. 2019	€ 102,237.00	15,988	6.39
Feb. 2019	€ 73,146.00	11,201	6.53
Last week of Feb. 2019	n.a.	n.a.	n.a.
Mar. 2019	€ 130,861.00	40,901	3.20
Apr. 2019	€ 265,960.00	50,533	5.26
May 2019	€ 200,393.00	49,178	4.07
Jun. 2019	€ 149,819.00	19,594	7.65
Jul. 2019	€ 114,205.00	13,871	10.40
Aug. 2019	€ 177,868.00	23,937	7.43
Sep. 2019	€ 187,707.00	21,842	8.59
Oct. 2019	€ 216,125.00	34,539	6.26
Nov. 2019	€ 205,799.00	35,512	5.80
Dec. 2019	€ 191,492.00	29,346	6.53

Table 28: Revenue per visitor for Palazzo Ducale of Mantua

C. GRETL OLS output for Musei Reali of Turin & Palazzo Ducale of Mantua

Model 1: OLS, using observations 1-6
 Dependent variable: Visitors

	coefficient	std. error	t-ratio	p-value	
const	207797	31111.8	6.679	0.0026	***
Years	47062.6	7988.76	5.891	0.0042	***
Mean dependent var	372516.3	S.D. dependent var	92981.73		
Sum squared resid	4.47e+09	S.E. of regression	33419.38		
R-squared	0.896655	Adjusted R-squared	0.870818		
F(1, 4)	34.70512	P-value(F)	0.004152		
Log-likelihood	-69.79858	Akaike criterion	143.5972		
Schwarz criterion	143.1807	Hannan-Quinn	141.9300		

Figure 49: OLS output for the Musei Reali of Turin using gretl

Model 1: OLS, using observations 1-6
 Dependent variable: Visitors

	coefficient	std. error	t-ratio	p-value	
const	216629	47271.2	4.583	0.0102	**
Years	22065.9	12138.1	1.818	0.1432	
Mean dependent var	293859.7	S.D. dependent var	61374.64		
Sum squared resid	1.03e+10	S.E. of regression	50777.40		
R-squared	0.452413	Adjusted R-squared	0.315516		
F(1, 4)	3.304777	P-value(F)	0.143225		
Log-likelihood	-72.30848	Akaike criterion	148.6170		
Schwarz criterion	148.2005	Hannan-Quinn	146.9497		

Figure 50: OLS output for the Palazzo Ducale of Mantua using gretl

D. Qualitative survey for the Gallerie Estensi of Modena & the Musei Reali of Turin

Gallerie Estensi

Ripartiamo insieme

*Campo obbligatorio

1. Hai usufruito delle iniziative online proposte dal Museo negli ultimi 3 mesi? *

Contrassegna solo un ovale.

Sì *Passa alla domanda 2.*

No *Passa alla domanda 4.*

2. Quanto spesso hai usufruito di tali iniziative? *

Contrassegna solo un ovale.

Più di 3 volte alla settimana

2-3 volte alla settimana

1 volta alla settimana

1-2 volte al mese

3. Quanto sei soddisfatto di queste iniziative? *

Contrassegna solo un ovale per riga.

	Poco	Abbastanza	Molto	Non ho partecipato
Le visite guidate virtuali	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I post su Instagram, Facebook e Twitter	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Le newsletter	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Il sito web	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4. Quante volte hai visitato il Museo lo scorso anno? *

Contrassegna solo un ovale.

Non sono andato/a

1 volta

2 volte

Più di 3 volte

5. Quanto ti faranno sentire sicuro le seguenti attività che il Museo ha messo in campo per fornire un'esperienza di visita in sicurezza? *

Contrassegna solo un ovale per riga.

	Per nulla sicuro	Parzialmente sicuro	Indifferente	Molto sicuro
L'ingresso al museo sarà permessa solo a persone che indossano una mascherina (disponibile anche nel bookshop)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
All'interno del Museo ci sarà gel igienizzante per le mani	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Non ci saranno fisicamente visite di gruppo e/o guidate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6. Quando pensi visiterai il Museo? *

Contrassegna solo un ovale.

- Nel mese di giugno
- Durante l'estate
- In autunno
- Quando sarà terminata l'emergenza sanitaria
- Non so
- Non ho intenzione di visitare il museo

7. A quale delle seguenti fasce d'età appartieni? *

Contrassegna solo un ovale.

- Under 18
- 18-30
- 31-50
- 51-65
- Over 65

8. Dove risiedi? *

Contrassegna solo un ovale.

- Risiedo in provincia di Modena
- Risiedo in provincia di Ferrara
- Risiedo in Emilia-Romagna, ma non in provincia di Modena né Ferrara
- Risiedo fuori dalla regione Emilia-Romagna
- Risiedo all'estero

Musei Reali Torino

Ripartiamo insieme

*Campo obbligatorio

1. Hai usufruito delle iniziative online proposte dal Museo negli ultimi 3 mesi? *

Contrassegna solo un ovale.

- Sì Passa alla domanda 2.
 No Passa alla domanda 4.

2. Quanto spesso hai usufruito di tali iniziative? *

Contrassegna solo un ovale.

- Più di 3 volte alla settimana
 2-3 volte alla settimana
 1 volta alla settimana
 1-2 volte al mese

3. Quanto sei soddisfatto di queste iniziative? *

Contrassegna solo un ovale per riga.

	Poco	Abbastanza	Molto	Non ho partecipato
I post su Instagram, Facebook e Twitter	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
La Newsletter	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Il sito web	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
L'App dei Musei Reali	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Il canale è Reale (ereale.beniculturali.it)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4. Quante volte hai visitato il Museo lo scorso anno? *

Contrassegna solo un ovale.

Non sono andato/a

1 volta

2 volte

Più di 3 volte

5. Quanto ti faranno sentire sicuro le seguenti attività che il Museo ha messo in campo per fornire un'esperienza di visita in sicurezza? *

Contrassegna solo un ovale per riga.

	Per nulla sicuro	Parzialmente sicuro	Indifferente	Molto sicuro
L'accesso al museo sarà contingentato, scaglionato per fasce orarie (massimo 80 persone in totale per ogni ora)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
All'ingresso sarà rilevata la temperatura e sarà obbligatorio l'uso della mascherina (disponibili anche nella cassa)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lungo il percorso di visita ci sarà gel igienizzante per le mani	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Le visite di gruppo e/o guidate avranno limitazione nel numero di persone	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6. Quando pensi visiterai il Museo? *

Contrassegna solo un ovale.

- Nel mese di giugno
- Durante l'estate
- In autunno
- Quando sarà terminata l'emergenza sanitaria
- Non so
- Non ho intenzione di visitare il museo

7. A quale delle seguenti fasce d'età appartieni? *

Contrassegna solo un ovale.

- Under 18
- 18-30
- 31-50
- 51-65
- Over 65

8. Dove risiedi? *

Contrassegna solo un ovale.

- Risiedo in provincia di Torino
- Risiedo in Piemonte, ma non in provincia di Torino
- Risiedo fuori dalla regione Piemonte
- Risiedo all'estero

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